

SCIENCE

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FRIDAY, DECEMBER 6, 1895.

CHARLES VALENTINE RILEY.

CONTENTS:

<i>Charles Valentine Riley</i> : A. S. PACKARD.....	745
<i>Biographical Notes on Louis Pasteur</i> : JULES MARCOU.....	751
<i>Unpublished Papers by Holbrook Cushman</i> : Edited by W. HALLOCK.....	757
<i>Measurements of the Accuracy of Recollection</i> : J. McKEEN CATTELL.....	761
<i>Current Notes on Anthropology (XIV.)</i> :— <i>Latest Words in Craniology</i> : Yucatecan Studies: D. G. BRINTON.....	766
<i>Current Notes on Physiography (XX.)</i> :— <i>The Distribution of Plants and Animals; Plants of the Alpine Region</i> : W. M. DAVIS.....	767
<i>Scientific Notes and News</i> :	768
<i>Educational Notes and News</i>	770
<i>Correspondence</i> :— <i>Testimony versus Evidence</i> : W. K. BROOKS.....	771
<i>Scientific Literature</i> :— <i>Dana's Minerals and How to Study Them</i> : S. L. PENFIELD. <i>Darwin's Elements of Botany</i> : L. H. BAILEY. <i>Murray's Introduction to the Study of Seaweeds</i> : W. A. SETCHELL. <i>Culin's Korean Games</i> : D. G. BRINTON	773
<i>Scientific Journals</i> :— <i>The American Journal of Science; Psyche</i>	777
<i>Societies and Academies</i> :— <i>Biological Society of Washington</i> : F. A. LUCAS. <i>The New York Academy of Science</i> : J. F. KEMP. <i>American Chemical Society</i> : DURRAND WOODMAN. <i>Boston Society of Natural History</i> : SAMUEL HENSHAW	778
<i>New Books</i>	780

THE career of this distinguished naturalist, so suddenly closed while in good health, and with apparently many years of usefulness before him, was a remarkable one. Biologist, artist, editor and public official, the story of his struggles and successes, tinged as it is with romance, is one full of interest. Beginning life in America as a poor lad on an Illinois farm, he rose by his own exertions to distinction, and to become one of our most useful citizens in science, both pure and applied. His nature was a many-sided one, and his success in life was due to sheer will-power, unusual executive force, critical judgment, untiring industry, skill with pencil and pen, and a laudable ambition, united with an intense love of nature and of science for its own sake. This rare combination of varied qualities, of which he made the most, rendered him during the thirty years of his active life widely known as a public official, as a scientific investigator, while of economic entomologists he was *facile princeps*.

Charles Valentine Riley was born at Chelsea, London, September 18, 1843. His boyhood was spent at Walton-on-Thames, where he made the acquaintance of the late W. C. Hewitson, author of a work on butterflies, which undoubtedly developed his love for insects. At the age of 11 he went to school for three years at Dieppe, afterwards studying at Bonn-on-the-Rhine. At

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both schools he carried off the first prizes for drawing, making finished sketches of butterflies, thus showing his early bent for natural history, and his teacher at Bonn urged him to study art at Paris. But it is said that family circumstances, though rather, perhaps, a restless disposition, led him to abandon the old country, and at the age of 17 he had emigrated to Illinois, and settled on a farm about fifty miles from Chicago. When about 21 he removed to Chicago, where he became a reporter and editor of the entomological department of the *Prairie Farmer*.

Near the close of the war, in 1864, he enlisted as a private in the 134th Illinois regiment, serving for six months, when he returned to his editorial office.

He also enjoyed for several years the close friendship of B. D. Walsh, one of our most thorough and philosophic entomologists, with whom he edited the *American Entomologist*. His industry and versatility as well as his zeal as an entomologist made him widely known and popular, and gave him such prestige that it resulted in his appointment in 1868 as State Entomologist of Missouri. From that time until 1877, when he left St. Louis to live in Washington, he issued a series of nine annual reports on injurious insects, which showed remarkable powers of observation both of structure and habits, great skill in drawing and especially ingenious and thoroughly practical devices and means of destroying the pests. The reports were models and will never become stale. Darwin wrote in 1871: "There is a vast number of facts and generalizations of value to me, and I am struck with admiration at your power of observation. The discussion on mimetic insects seems to me particularly good and original." In reviewing the ninth and last of these reports, published in 1876, the *Entomologists' Monthly Magazine* of London, remarked: "The author, in giving full scope to his keen powers of observation,

minuteness of detail, and the skill with which he uses his pencil, and at the same time in showing a regard for that scientific accuracy—unfortunately too often neglected in works on economic natural history—maintains his right to be termed the foremost economic entomologist of the day." It goes without saying that this prestige existed to the end of his life, his practical applications of remedies and inventions of apparatus giving him a world-wide reputation. In token of his suggestion of reviving the vines injured by the *Phylloxera* by the importation of the American stock, he received a gold medal from the French government, and he afterwards received the cross of the *Légion d'Honneur* in connection with the exhibit of the U. S. Department of Agriculture at the Paris Exposition of 1880.

The widespread ravages of the Rocky Mountain locust from 1873 to 1877 had occasioned such immense losses in several States and Territories that national aid was invoked to avert the evil. The late Dr. F. V. Hayden, then in charge of the U. S. Geographical and Geological Survey of the Territories, with his characteristic energy and sagacity, initiated researches on the locust in the Territories. He sent Dr. P. R. Uhler to Colorado in the summer of 1875, and also attached the present writer to the Survey, who spent over two months in entomological work in the same year in Colorado, Wyoming and Utah, publishing the results in Hayden's Ninth Report. Mr. Walsh had made important suggestions as to the birthplace and migrations of the insect. Meanwhile Riley had since 1874 made very detailed studies on the migration and breeding habits and means of destruction of this locust (published in his Missouri State Report for 1876 and 1877). Dr. Cyrus Thomas had also been attached to Hayden's Survey, and published a monograph on the locust family, *Acrydidæ*. As the result of this combined work Congress cre-

ated the United States Entomological Commission, attaching it to Dr. Hayden's Survey, and the Secretary of the Interior appointed Charles V. Riley, A. S. Packard and Cyrus Thomas members of the Commission. Dr. Riley was appointed Chief, and it was mainly owing to his executive ability, business sagacity, experience in official life, together with his scientific knowledge and practical inventive turn of mind in devising remedies, or selecting those invented by others, that the work of the Commission was so popular and successful during the five years of its existence. Meanwhile in 1878 while the report of the Commission was being printed, Riley accepted the position of Entomologist to the U. S. Department of Agriculture, and during the season of 1879 and 1880 he investigated the cotton insects, but owing to the lack of harmony in the Department, he resigned, Prof. J. H. Comstock being appointed, and ably filling the position. Congress meanwhile transferred the cotton-worm investigation to the Entomological Commission. Riley was reappointed to the position of U. S. Entomologist in June, 1881. His successor, Mr. L. O. Howard, has stated how efficient, broad and thorough was his administration of this office: "The present efficient organization of the Division of Entomology was his own original conception, and he is responsible for its plan down to the smallest detail. It is unquestionably the foremost organization of its kind at present in existence." Again he writes: "Professor Riley's work in the organization of the Division of Entomology has unquestionably advanced the entire Department of which it is a part, for it is generally conceded that this division has led in most matters where efficiency, discipline and system were needed. Its plan and discipline have been cited by one of the heads of the Department as worthy of imitation by all, and your own honored Westwood,

in expressing, in 1883, his admiration of Riley's work, said: 'I am sure it must have had a great share in inducing the activity in entomological work in America, which is putting to the blush the entomologists of Europe.' "

Indeed, so efficient, methodical and painstaking was Riley in whatever he undertook to do that had he been promoted to the position of Commissioner of Agriculture he would have been head and shoulders above any incumbent of that office, and, it is safe to say, would have administered its affairs with practical results far more valuable than those attained by any other Commissioner, as such an office should have been entrusted to a person who had had a scientific education, and not given as a reward for political service. As it is, he was the leader, says Mr. Howard, in many important innovations in the work of the Department. His division published the first bulletin, and in 'Insect Life' began the system of periodical bulletins, which has since been adopted for the other divisions of the Agricultural Department. He also took a large share in founding the Division of Economic Ornithology, Silk Culture and Vegetable Pathology, the first two being placed for some time under his charge. In an address, says Howard, before the National Agricultural Congress, delivered in 1879, in which he outlined the ideal Department of Agriculture, Professor Riley foreshadowed many important reforms which have since become accomplished facts, and suggested the important legislation, since brought about, of the establishment of State Experiment Stations under the General Government.

His practical, inventive genius was exhibited in his various means of exterminating locusts, in the use of kerosene oil emulsified with milk or soap, and in his invention and perfection—in which he was essentially aided by the late Dr. W. S. Barnard, who had special charge of the sub-

ject of mechanical appliances and remedies while connected with the Entomological Commission and the Agricultural Department, and whose 'assistance was fertile from the first,' as stated by Riley in his report—of the 'cyclone' or 'eddy-chamber' or Riley system of nozzles, which, in one form or another, are now in general use in the spraying of insecticide or fungicide liquids.

Although the idea of introducing foreign insect parasites or carnivorous enemies of our imported pests had been suggested by others, Riley, with the resources of his division at hand, accomplished more than any one else in making it a success. We will let Mr. Howard tell the story of his success, with the efficient aid of Mr. Albert Koebele, in introducing the Australian lady-bird to fight the fluted scale:

"One other trait which we have not mentioned is his *persistence in overcoming obstacles*. Nothing daunts him, and the more difficult an end is to attain, so much the more energy and perseverance does he put in its pursuit. A recent instance of this quality we may cite: The fluted scale (*Icerya purchasi* Maskill) has done immense injury to citrus fruit in southern California of late years. Ascertaining that it is kept in check by natural enemies in its native home, Australia, Dr. Riley foresaw the importance of endeavoring to introduce these enemies. Not only did Congress refuse to appropriate money for the purpose, but it refused to do away with a clause in the Appropriation Bill restricting all expenditures to the United States. In this state of affairs most men would have given up the fight; but Dr. Riley, after great trouble, succeeded in accomplishing his end by inducing the Secretary of State to allow the sending of two assistants on the Melbourne Exposition Commission, and through their labors the desired result was reached." Hundreds of specimens of an Australian lady-bird (*Vedalia cardinalis*) were introduced into California, and the dreaded pest is now being speedily reduced to absolute harmlessness. Professor W. A. Henry, of Wisconsin, in a recently-published article, says of this matter, in speaking of the enthusiasm of the people of California over the results of this importation: 'Without doubt it the best stroke ever made by the Agricultural Department at Washington.'"

It might be thought that all this admin-

istrative work of the office and in the field would have left little time for pure science or for much general reading or deep thinking. Let us see what he actually did accomplish in pure science. Riley's scientific writings will always stand, and show as honest work, thorough-going methods, care and accuracy as his office work, and they alone, aside from his practical work, were enough to give him an international reputation. In some of his studies he was probably essentially indebted to his assistants for specimens and aid in rearing them; in others he evidently depended on his own unaided observations and his skill in drawing. He was not 'a species man' or systematist as such; on the contrary his most important work was on the transformations and habits of insects, such as those of the Lepidoptera, locusts and their parasites, his Missouri reports being packed with facts new to science. His studies on the chronology of all the broods known of the 17-year cicada, and its *tredecim* or 13-year race, carried on through a long succession of years, will prove of lasting value, having intimate bearings on evolution problems.

His work on the larval characters and hypermetamorphoses of the blister beetles, *Epicauta*, *Macrobasis* and *Hornia*, besides *Henous*, was thoroughly good and beautifully illustrated by his own pencil. He brings forward in this paper a mass of new facts regarding the triungulin, or first larval stage of these beetles, and those succeeding, which he designates as the Carabidoid, the Scarabæidoid stage, the Coarctate or quiescent larva, these stages preceding the pupa stage. The value of these facts as set forth by so trustworthy and keen an observer, and corroborating and greatly extending those worked out by European observers, is apparent when we consider that the triungulin larva is perhaps the nearest approach to the Campodea-like ancestor of the winged insects, that the Meloidæ are consequently

among the most primitive and generalized of Coleoptera, and that from work based on such studies as these of the life-history of this and allied groups there has already resulted the germs of a truer phylogeny or classification of the entire order of Coleoptera. Of similar import are Riley's papers on the larval habits of bee-flies, on the luminous larviform females of the Phengodini and on the first larval stage of the pea-weevil (*Bruchus*). His studies on the systematic relations of *Platypsyllus* as determined by the larva evince his patience, accuracy and keenness in observation and his philosophic breadth.

For over twenty years he made observations on the fertilization of *Yucca* by those remarkable tineoid moths, *Pronuba* and *Prodoxus*, and from time to time published papers and notices of progress in his work which culminated in his paper entitled 'The *Yucca* Moth and *Yucca* Pollination' (1891-'92), a memoir remarkable for the patient, unremitting work carried on during his spare hours, its thoroughness in dealing with structural details, its critical accuracy, and for its faithful and artistic drawings. It is a paper of interest to botanists as well as zoölogists, and of value to the student of evolution. One of his last papers was a continuation and résumé of this subject entitled 'Some Interrelations of Plants and Insects' (1892).

Riley's contributions to the history and structure of the *Phylloxera*, of the scale insects, of the hop-plant louse, the *Pemphiginae*, *Psyllidæ*, etc., are of permanent interest and value. His best anatomical and morphological work is displayed in his study on the mode of pupation of butterflies, the research being a difficult one, and especially related to the origin of the cremaster, and of the vestigial structures, sexual and others, of the end of the pupa. Whatever he did in entomology was original. He may occasionally have received

and adopted hints and suggestions from his assistants, but he laid out the plan of work, supervised every detail, followed up the subject from one year to another, and made the whole his own. His originality in a quite different direction from biology is seen in his paper entitled 'Perfectionnement du Graphophone,' read before the French Academy of Sciences at Paris, in 1889. He was also much interested in *Aéronautics*, and took much delight in attending séances of spiritualists and exposing their frauds, in one case, at least, where another biologist of world-wide fame, then visiting in Washington, was completely deluded.

Riley was from the first a pronounced evolutionist. His philosophic breadth and his thoughtful nature and grasp of the higher truths of biology is well brought out in his address on 'The Causes of Variation in Organic Forms,' as Vice-President, before the biological section of the American Association for the Advancement of Science in 1888. He was a moderate Darwinian, and leaned, like other American naturalists, rather to Neo-Lamarckism. He says: "I have always had a feeling, and it grows on me with increasing experience that the weak features of Darwinism and, hence, of natural selection, are his insistence (1) on the necessity of slight modification; (2) on the length of time required for the accumulation of modifications, and (3) on the absolute utility of the modified structure." Riley from his extended experience as a biologist was led to ascribe much influence to the agency of external conditions, remarking, in his address: "Indeed, no one can well study organic life, especially in its lower manifestations, without being impressed with the great power of the environment." He thus contrasts Darwinism and Lamarckism: "Darwinism assumes essential ignorance of the causes of variation and is based on the inherent tendency thereto in the offspring.

Lamarckism, on the contrary, recognizes in use and disuse, desire and the physical environment, immediate causes of variation affecting the individual and transmitted to the offspring in which it may be intensified again both by inheritance and further individual modification."

The following extracts will illustrate his clear and vigorous style of thought and expression and his attitude on the relations between science and religious philosophy. Regarding the question of design he says: "Both Lyell and Gray believe in the form of variation having been planned or designed. It seems to me that the evidences of design in nature are so overwhelming that its advocates have an immense advantage over those who would discard it. A fortuitous cosmos is, to most persons, utterly inconceivable, yet there is no other alternative than a designed cosmos. To accomplish anything by a process, or by an instrument, argues greater, not less power, than to do it directly, and even if we knew to-day all the causes of variation, and understood more thoroughly than we do the method of evolution, we should only carry the sequence of causes a step further back and get no nearer to the Infinite or Original Cause."

"Evolution teaches that nothing is yet so perfect but it may be improved; that good comes of the struggle with evil and the one can never be dissociated from the other. The erect position which has given man his intellectual preëminence has brought him manifold bodily ills. No evolutionary sibyl looks to a millennium. Higher development must ever mean struggle. Evolution shows that man is governed by the same laws as other animals." "Evolution reveals a past which disarms doubt and leaves the future open with promise—unceasing purpose—progress from lower to higher. It promises higher and higher intellectual and ethical attainment, both for the individual

and the race. It shows the power of God in what is universal, not in the specific, in the laws of nature, not in departure from them."

"The experience gained by those who have reached the highest ethical and intellectual growth must be formulated in precept and principle to be of any benefit to society at large, and the higher ethical sentiment and religious belief—faith, love, hope, charity—are priceless beyond all that exact science can give it."

Riley, an excellent head of a bureau, but sometimes uncomfortable and too independent as a subordinate, at times got into hot water with his superiors in the Department. He was sensitive to criticism, and was somewhat prone to controversy, usually, however, winning in such encounters. Until one came to know him more intimately he was liable to be misunderstood, and by his occasional bluntness made some enemies, but as years rolled on these passing antagonisms melted away.

Vigorous in mind and body, though of late years suffering from overwork, fond of out-door sports, he was a fearless rider on horseback, and an adept with the bicycle, on which, alas, he rode to his death.

His hospitable house at Sunbury was beautified by rare flowers, shrubs and trees, of which he was passionately fond. He was domestic in his tastes, and left a wife and five children to mourn his loss.

Riley left an indelible mark on his time, and the historians of natural science and of agriculture in America will scarcely ignore the results of thirty years of earnest work in pure and applied entomological science.

His scientific honors were well deserved. He was a member of many societies at home and of the entomological societies of France, Berlin, Switzerland and Belgium. He was elected in 1889 an Honorary Fellow of the Entomological Society of Lon-

don, and was also Honorary Fellow of the Royal Agricultural Society of Great Britain. He was for two years President of the Academy of Science of St. Louis, being the youngest member so honored. He was founder, and for two terms President, of the Entomological Society of Washington, one of the founders of the Biological Society of that city, and an honorary member of the horticultural societies of Illinois, Iowa, Kansas and Missouri. The Kansas State Agricultural College gave him the degree of A. M., and the Missouri State University in 1873 conferred upon him the degree of Ph. D. He was lecturer on entomology at Cornell University and at other institutions.

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BIOGRAPHICAL NOTES ON LOUIS PASTEUR.

A DISTINGUISHED chemist, Dean of the Bussey Institution, Harvard University, Francis H. Storer, said a few days before the death of Pasteur, "Pasteur is the greatest genius produced in this century," and, he added, "He is a chemist."

As it has been my good fortune to be intimate with Pasteur since our college days, living in the same room, as *chum*, during several years, and keeping up our intimacy, notwithstanding my wandering life in both hemispheres, a few words of remembrance may be acceptable. I have before me at this moment a bundle of his letters, the first one dated 10 June, 1845, and the last dated 14 December, 1887, with letters after that date from his wife to keep me 'au courant' of his failing health; all his memoirs and papers, bound in 7 volumes, each one with a dedication in his handwriting, such as, 'A mon ami Jules Marcou, souvenir affectueux, L. Pasteur;' and three portraits, taken in 1863, 1868 and 1891, all with dedication, as, "A mon ancien et bon camarade Jules Marcou, souvenir affectueux, L. Pasteur." So I am pretty well able to

give exact information on his life and character.

Born at Dole, Jura, 27 December, 1822, in the 'rue des Tanneurs, 43,' (Tanners street), where a marble table was erected the 19th of July, 1883, with the inscription 'Ici est né Louis Pasteur, le 27 Décembre, 1822;' Pasteur was removed a few weeks later to a small tannery on 'La Vache' creek, between the village of Marnoz and the Chateau de St. Michel, near Salins, Jura, and remained there until the fall of 1829; when his father finally took a tannery on 'La Cuisance' creek, at the western outlet of the little town of Arbois, Jura, where Pasteur was educated and kept his home until his death. The family originally came from Salins, Jura, where during the eighteenth century they were well known as tanners. His father was born there, and his mother, *née* Roqui, at the village of Marnoz, Canton of Salins. Jean Joseph Pasteur, born in 1790, did not receive a classical education; he took the profession of his family, and was a journeyman tanner at Salins, when the conscription took him in 1811, and sent him as a private in a regiment of infantry, in Spain. There by his bravery, good conduct and capacity, he was rapidly raised to the rank of sergeant-major, and decorated Knight of the Legion of Honor, not an easy position to reach in the French armies scattered all over Spain, far from Napoleon and consequently much neglected as regard promotion and decoration of the Legion of Honor. Dismissed from military service in 1815, Pasteur returned to Salins, and resumed his work as a tanner. He was a good looking and very intelligent man. If he had received an education he would have made his mark. Knowing how important education was, he did all in his power to do to give his son an opportunity. First, Louis Pasteur became a pupil at the small college of Arbois, from 1831 to 1839, then he was sent as an 'interne' to the

College Royal of Besançon, where he stayed from 1839 until 1842. There he took in 1840 the title of Master of Arts, or 'Bachelier,' and prepared for the 'Ecole normale Supérieure.' Then he did not show any aptitude for chemistry; it is true that the old professor of chemistry and physics was a old fashioned savant, extremely diffuse in his lectures, and Pasteur was not attracted by the lessons; so much so, that it was I, who have but little capacity for the work, who was chosen as the assistant by the professor. There was no pay, and the professor chose for his assistant the pupil that he liked best, provided he was an 'interne,' in order to have him within reach one or two hours before his lecture to prepare the experiments and the instruments. Then Pasteur was not what is called a brilliant student, but he was a good one, standing second in our class, myself being No. 3. As a great privilege, the provisor of the college gave to Pasteur and me one room, where we worked and slept, instead of being obliged to be with the other pupils in the 'Salle d'Etudes,' and in a great dormitory. Our room was only whitewashed, and our furniture most elementary. What Pasteur did, at once, was to make a good fresco picture, on the side of the wall above the blackboard. That picture, well executed considering the time and the youth of the painter, represented a scene of Childe Harold of Byron. Pasteur had a remarkable disposition for artistic work, and we all thought then that he would become an artist; so much so that we called him, as a nickname, 'The Artist.' And the title stuck to him many years after his college life. I may add that he drew my portrait in colored pencil, at that time a good likeness, when I was eighteen years old. I possess it still, it is signed 'P.(asteur) L.(udovicus) del (delineavit), 1842.'

From 1843 to 1846 Pasteur was a pupil of the *Ecole Normale Supérieure*, following the

lectures of the Sorbonne, as is the custom. The third year he chose the 'Sciences physiques et chimiques,' and graduated an 'Agrégé' for those sciences in August, 1846. It was during his stay at the Normal School that Pasteur showed his taste for chemistry. He was in perfect rapture at the end of each lecture on chemistry by the two ordinary professors of that science then at la Sorbonne, Messrs. Balard and Jean Baptiste Dumas. To be sure Pasteur admired the talent of exposition of Dumas; but was a little shocked by his way of dressing too much like a scientific dandy, by his too studied posture and by his affectation. It was not so with Balard, who was entirely sympathetic to the modest tastes of Pasteur. But what attracted most of his attention was neither Balard nor Dumas, but their assistant, then a rather old man, M. Barruel. As a practical chemist, a skilful manipulator, Barruel had few equals, if any; all the operations always succeeded with such precision, exactness and at the right time that Pasteur was absolutely astounded and in perfect rapture. I have seen him, at the end of some of those lectures, with his eyes filled with tears, ready to cry; so much was he moved by what he had heard and seen.

At the end of 1846 Pasteur was appointed assistant to Professor Balard, who was 'Maître des conférences de chimie,' at the Normal School; a new post, poorly paid and rather difficult to obtain from the French government, which then was sparing in regard to new scientific expenditures. All that Pasteur wanted was to stay in Paris, no matter how poorly he was paid. At that time the Normal School was on the point of being removed from the old and inadequate building of the annex of the Louis-le-Grand College, to a large and even beautiful mansion built especially for that purpose in the rue d'Ulm. The school was not removed, however, until September,

1847; but the two laboratories for chemistry and physics were ready for occupancy in 1846, and Pasteur, who had charge of the Chemical one, began at once the installation, being with Bertin, the physicist, the two first inhabitants of the new Normal School mansion. For the time the laboratory was excellent, even luxurious, and from the first day, with the help of a young man named Thomas, who acted as servant, and has since become a very able professional chemist, Pasteur became that extraordinary manipulator, unequalled in the history of chemistry for exactness, sharp and delicate observations.

The first work of Pasteur is on crystallography and rotatory polarization; and to the surprise of Biot and Mitscherlich he created a new chapter of chemical crystallography, by his discovery in regard to the tartrate crystals. Then he worked on dimorphism. During the year and a half that Pasteur passed as chemical assistant at the Normal School incessant laboratory work took all his time; often he was at the laboratory at 6 a. m., and at 12 o'clock p. m. he was still studying, in his room, chemical books borrowed from the Library.

We used then to take our meals together; hardly speaking to one another at breakfast, so full we were, both of us, of our work. It was only at dinner time that we exchanged our thoughts; walking after dinner first to my room, rue d'Enfer, 51; Pasteur and I, would get up the four stories, and pass one or two hours talking on scientific subjects, travels, etc., often two or three other friends joined us, such as Quintino Sella, the mineralogist and Italian statesman; Bartholomeo Gastaldi, the geologist; A. Pomel, the paleontologist and geologist, and Oscar Fraas, the geologist. Then Pasteur always pursuing an idea, would take French leave and go to his room in the rue d'Ulm. We never went into society, or to

theatres, or to 'cafés,' taking now and then a walk, in the Luxembourg Garden; in fact our lives were hermit lives, entirely devoted to science and friendship.

It was during those two years, October, 1846, to March, 1848, that Pasteur learned to be such an expert in chemical laboratory work; and he owed a great deal to the private teaching of old Barruel, the chemical assistant at la Sorbonne. But he was also a rare and unique pupil, extremely skillful with his hands, with near-sighted eyes, which scrutinized everything, and let pass nothing without seeing what it was, extremely patient, never tired when at work, and with those great qualities not an absent minded man, always being on the contrary wide-awake.

In May, 1848, Pasteur, who had taken his degree of doctor of physical and chemical sciences at the end of 1846, was appointed professor of physics and chemistry at the lyceum of Dijon, where he stayed only three months, being called to the faculty of science at Strasburg, first as substitute, and three years later as full professor.

During the five years he passed at Strasburg, from October, 1848, to August, 1854, Pasteur studied the correlations between dissymetry and the deviation of polarized light in minerals. He proved that the molecular dissymetry is the only sharp demarcation existing between the chemistry of 'la nature morte' and the chemistry of 'la nature vivante.' It was during his stay at Strasburg that Pasteur married Miss Mary Anne Laurent, daughter of the rector of the academy at Strasburg. It is said that he was working so steadily at an experiment in his laboratory, the morning of his his wedding, that some friend was obliged to go there and bring him up to be prepared for the ceremony. Never was a better match and a more harmonious couple.

In October, 1854, Pasteur removed to Lille, where he had been appointed dean of

the new faculty of science just created then by the French government. As soon as installed in his new position he began the work which has given him his world wide reputation—his study of the ferments. He was then thirty-two years of age, and had never studied physiology, anatomy or biology, and notwithstanding the difficulties inherent to such a change in the direction of his researches, leaving the physical and chemical molecular works, he turned abruptly to physiology, against the advices of his friends and patrons, Biot and Dumas.

Pasteur began his studies on ferments with milk, finding there bacteria so small that their diameter was only the thousandth part of a millimetre. Then he took the transformation from wine into vinegar; when suddenly he was confronted by a very sharp opposition brought up by Félix A. Pouchet, of Rouen, on the question of spontaneous generation. Pasteur saw at once that the origin of microbes was not to be eluded any longer, and without hesitation he began a series of observations requiring the greatest care, ability and keen attention which had perhaps ever been given before in laboratories. Every scientific friend of Pasteur tried to dissuade him from such researches, except one, the great crystallographer, M. de Senarmont, who had an absolute confidence in the extraordinary ability of Pasteur as an experimenter. The great success achieved by Pasteur has put now to rest forever the question of spontaneous generation, which broke the first ring in the chain of the 'Origin of Species' of Darwin. It is curious that neither Darwin nor any of his followers had ever tried to oppose Pasteur; not but that opponents in England made, like Pouchet, objections and presented observations which seemed to break Pasteur's experiments; but little by little all opponents left the field, and John Tyndall did not hesitate to accept and uphold Pasteur's views.

The studies on wine, which followed closely those on vinegar, required a great deal more research, and the volume published by Pasteur: 'Etudes sur le vin, ses maladies etc' in 1866, is and will remain the standard work. The amount of money saved by Pasteur's method of treating diseased wine may be counted by millions and millions of francs; for it is used not only in France but in every wine growing country.

The French government, justly desirous to put an end, if possible, to a sort of pest among the silkworms which destroyed almost all the fortunes of the southern part of France devoted to that industry, asked Pasteur to go there and study the sickness of the silkworms. Dumas, the chemist, told the Emperor Napoleon III., "if anybody can do anything about it, it is Pasteur!" At first Pasteur was unwilling to abandon his work on ferments, which had already given such great result; and it was only to the pressing solicitation of Dumas, who was from a district of Languedoc, most affected and almost totally ruined by the pest on silkworms, that Pasteur yielded at last. On taking leave of me, he said: "I do not know, what I am going to find; it is *la bouteille à l'encre*!"

Pasteur worked steadily during five years at the silkworms, with the splendid result of finding a practical way to stop the pest; and now the silk industry of France, Italy and other European countries engaged in producing silk is more prosperous than it ever was before the epidemic.

In the two volumes: 'Etudes sur la maladie des Vers à Soie,' 1870, Pasteur has given to the world all his researches and remedies. It is in Vol. I, p. 99, that we read the following prophetic sentence, of which his subsequent discoveries have given such a splendid confirmation: 'Il est au pouvoir des hommes,' says he, 'de faire disparaître de la surface du globe les

maladies parasitaires, si, comme c'est ma conviction, la doctrine des générations spontanées est une chimère.'

Pasteur remained only three years at Lille, and in October, 1857, he removed to Paris, as director of the Scientific Section of the Normal School, taking his residence again rue d'Ulm, nine years after leaving it in 1848. This time he was finally settled in Paris. He knew well that the excessive centralization of France obliged a savant to be in Paris, if he wanted not only to be appreciated, but also to get sufficient help from the government for his researches. At first he had no laboratory, being obliged to build one at his own expense in the garret of the Normal School. By and by a vast and good laboratory was built, exclusively for his own use, in the yard directly on the left after entering the gate of the school. A marble slab has been lately placed against it, recalling that it was the Pasteur Laboratory. It was there that most of his discoveries in bacteriology were made.

In October, 1868, Pasteur was struck by a very strong attack of hemiplegy; during several days he was in constant danger of losing his life, and for months he was so infirm as to be unable to leave his bed or his room. Little by little, however, he recovered—a wonderful case of recovery. Paralyzed on the left side, his arm and leg kept visible marks of the paralytic stroke, and he looked always as a wounded man; but happily his mind was never affected, after the immediate danger was past. I remember one night, when I kept watch over him, his eyes—always very beautiful—were almost lighted up by happiness. "You are surprised to see me so contented; it is because I begin to feel that I shall get out of this terrible sickness; my head is full of thoughts because I have so much to do with the ferments!" His desire of prolonging his life was mainly in order to continue his works

on bacteriology. What an infatigable worker! Being only forty-five years old, and having never abused anything but too hard work; Pasteur rallied, and was able to go again to Alais, in Languedoc to continue his observations on the silkworms. The next year he was in Italian Austria, at the villa Vicentina, near Trieste, carrying on his researches; when the news of the declaration of war between France and Prussia reached him. He started at once to come back, passing through southern Germany. What he saw in passing at Munich had made him anxious; and I remember a visit which he received at the beginning of August of General Favé, the commanding officer of the Polytechnic School. The general told him that the arms possessed by the French army were so much superior to those of the Germans that no fear was to be entertained as to the final result.

Pasteur received notice from Marechal Vaillant, a few days after his return, that the Emperor Napoleon was so satisfied with his work on the silkworms that he has just signed his nomination as a Senator. But the nomination was never printed in the *Journal Officiel*, and was left in the hurry of the departure on the desk of the Emperor; so Pasteur was only a Senator *in partibus*.

Pasteur was a very strong patriot; the defeat of the French armies went to his heart so strongly that he abandoned all work, and for the first time his laboratory was deserted. Having retired at his house at Arbois, he passed a most distressing winter, crying like a child at the reading of newspapers. When Franche-Comté was invaded he left Arbois to retire to Switzerland. Passing through Pontarlier he found there the retreating columns of Bourbaki's army in great confusion, and among them he met his only son, Jean Baptiste, a corporal of chasseurs.

As soon as he was able to recover his balance Pasteur went to Clermont-Ferrand,

in Auvergne, where his favorite pupil, M. Duclaux, was professor of chemistry, and there in his laboratory, during the Commune, Pasteur began his series of researches on the ferments of beer, which resulted in the publication, in 1876, of his magistral work, '*Etudes sur la Bière, ses maladies, etc.*'

We have come now to the work, which has placed Pasteur at the head of the Philanthropists, as the greatest benefactor of humanity. First it was his discoveries of antiseptics, which, as Dr. Lister says in a letter to Pasteur, dated February, 1874, was suggested to him by the reading of his studies on the germs of putrefaction. It was not without hesitation that Pasteur became a physiologist, as he said often then, "I am neither a Doctor of Medicine nor a veterinary surgeon;" but good words to encourage him came from many masters of science, such as Claude Bernard, Rayer, Bouley, Paul Bert, Tyndall, Huxley, etc. In a letter dated February, 1876, Tyndall expresses his unbounded admiration for the researches of Pasteur, saying that "thanks to his works, medical sciences will soon get rid of empirical methods and be placed on true scientific bases."

The discovery of the bacteria of the anthrax conducted Pasteur to the sure cure of that terrible and disastrous sickness among sheep, oxen and horses, saving millions of francs to agriculturists and stock breeders; then came in succession the septicæmia, the cholera of chickens and hydrophobia. The last discovery is the one which made Pasteur so popular; persons bitten by mad dogs and mad wolves came from Russia, Germany, Austria-Hungary, England, Algeria, even America, to be inoculated and treated. At first Pasteur was very timid; and the first two of his patients, who died, notwithstanding his care, were very distressing to him; but medical colleagues encouraged him, saying

that some cases are refractory to all sorts of medications, and the brilliant results of numerous cures, shown by careful statistics, soon put an end to his hesitations.

The cure of diphtheria, although not made by Pasteur, was inspired by him, and Dr. Roux followed closely all the directions and suggestions made to him by his illustrious master and teacher.

Pasteur met many opponents, for it is in human nature to oppose discoveries made against accepted theories, and savants occupying exalted position do not like to be interfered with. In Germany Liebig and Koch, in England Dr. Bastien, and in France Berthelot and Pouchet, made opposition not exempt from passion and jealousy. The attack of Berthelot, who published, six months after the death of Claude Bernard, a posthumous paper found in notes, rather incomplete and confused even, which if true was the inauguration of a new system of spontaneous generation among the ferments of grape wine, took Pasteur by surprise and was very painful to him, for he has always professed a great admiration for Claude Bernard, with whom he was in most intimate friendship. Without losing time, Pasteur started for Arbois and carried out delicate experiment, in one of his own vineyards, which after one year showed most conclusively the mistake of both Bernard and Berthelot. This discussion is printed in full, in '*Examen critique d'un écrit posthume de Claude Bernard sur la fermentation*,' 1879.

Pasteur received more honor during his life than any other savants ever did, and he entered into immortality before his death. The honors bestowed on him were all well deserved; for not only did he orient a new medical science, surgery, the veterinary arts, the making of beer, wine and vinegar, but he always declined to take patents of any sort, notwithstanding most tempting offers of large sums of money

from speculators, saying that he was paid by the French government and that all his discoveries belonged to the public. As Huxley says: "The discoveries of Pasteur are sufficient alone, to have repaid all the tribute of war of five milliards of francs paid by France to Germany."

In our time, when money seems to be everything, and when we have the discouraging spectacle of competitions to get at great fortunes by all means, it is a great example to see a man refusing to be tempted and perfectly satisfied with a modest pension of 12,000 francs yearly, soon raised to 25,000 francs during his life, to be continued to his widow and afterwards equally divided between his two children. To be sure the honor is unique. His public funeral, also at the national expense, attended by the President of the French Republic, and followed by the mass of the population, without regard to parties, is another noble manifestation, unmixed with any discordant notes, from the humblest citizen, and even children, to his highest surviving contemporaries.

One more word, Pasteur's last creation was his Institut, rue Dutot, built by private subscriptions and sustained by rents from a yet too small capital, increased happily yearly by annual appropriations from the French budget. There the new roads he opened to science will continue to attract the attention of the scientific world, and discoveries will go on under his direction and methods. Pasteur was very anxious to place it on a sure and somewhat independent basis, and in the last letter he wrote me with his own hand, when already stricken with the ailment which terminated his life, he says:

"INSTITUT PASTEUR,

PARIS, le 14 décembre, 1887.

MON CHER MARCOU:

Je suis heureux des bonnes nouvelles que tu me donnes de ta santé. La mienne

a été éprouvée dans ces derniers temps par une congestion qui m'a rendu la parole un peu difficile. Quoiqu'il en soit je suis, depuis quelques semaines, une hygiène de repos et de calme qui me réussit assez bien.

Tout va bien au laboratoire et l'Institut Pasteur, est presque terminé, moins l'aménagement intérieur. L'inauguration cependant n'aura lieu qu'à la fin de l'été prochain et nous n'en prendrons possession qu'en Novembre, 1888. Ce sera grand et confortable et de bel aspect. La souscription a dépassé deux millions. Avec le legs récent de Madame Boucicaut (du *Bon Marché*) et un autre legs d'un négociant de Lyon, elle dépassera deux millions deux cent mille francs. Les constructions et l'achat du terrain atteindront douze cent mille francs et plus.

Nous avons donc besoin d'accroître encore beaucoup notre capital. J'ai confiance en de nouveaux legs.

Ah! si nous étions en Amérique, le pays aux généreuses et grandes initiatives!

Déjà nous rendons mille actions de grâce à la très digne Madame Boucicaut qui n'a pas contribué à la souscription pour moins de deux cent cinquante mille francs.

Je m'arrête. Ecrire me fatigue encore par l'obligation de courber la tête.

Tous les affectueux souvenirs de Mme Pasteur et de moi, à Mme Marcou et à Monsieur Philippe, à toi mille bonnes amitiés.

L. PASTEUR."

JULES MARCOU.

CAMBRIDGE, MASS, 14th November, 1895.

HOLBROOK CUSHMAN.

HOLBROOK CUSHMAN was born in New York City, in 1857, and was there prepared for college, entering Columbia in 1874. He was graduated with honors in 1878, receiving the 'Fellowship in Science.' From Columbia he went to the University at Würzburg, Bavaria, studying physics with Kohlrausch, mathematics with Prym and

Selling, and chemistry with Wislicenus. After three years work at Würzburg he went for a year to Helmholtz at Berlin. After his return to America in 1882, and until 1890, he was chiefly occupied with commercial applications, having been for several years with a large firm manufacturing electrical supplies in England, and subsequently he was connected with a similar firm in this country. In 1890 he was appointed assistant in physics at Columbia, and quickly rose to the rank of instructor, which he held at his death, on October 25, 1895.

As a man and a friend he was all that the words in their best sense imply.

If one were to judge Mr. Cushman's services to science by his published work, one would obtain a most incomplete idea of their extent. Although deeply interested in the more theoretical questions which have specially occupied physicists in the past score of years, and always willing to discuss them, still his heart was chiefly set upon the practical applications, not in a commercial sense, but referring to teaching or research. Many pieces of very useful apparatus and many excellent laboratory methods are the results of his activity in this field. His chief service to science, and the one which will remain as a lasting monument to the strongest side of his activity, is the admirable organization of the laboratory teaching of physics at Columbia. To his untiring industry and thorough devotion is due a system which handles 400 students annually in a limited space, giving to each a course adapted to his individual needs. For each of the experiments, some 200 in number, he has prepared full explanations and instructions for making the determination. It is proposed to issue this collection with some little additional material as a laboratory manual for the use of our students. It is also proposed to contribute to SCIENCE several

papers on methods and apparatus prepared by him and left unpublished at his death.

Collimating Magnetometer and Local Variometer.

Unpublished paper by HOLBROOK CUSHMAN.

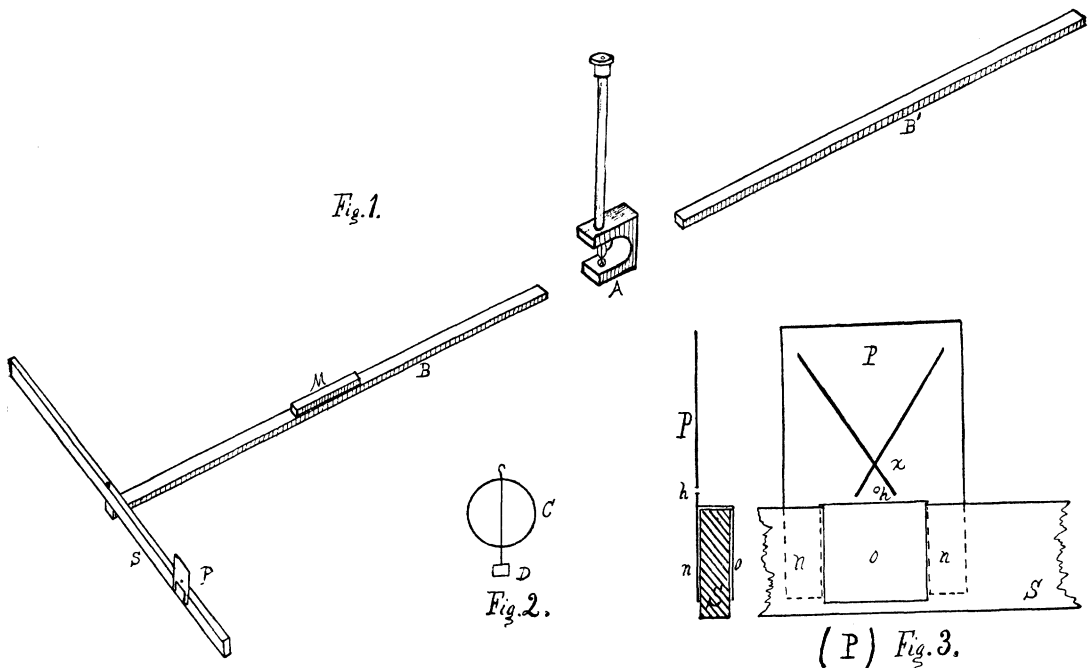
Edited by W. HALLOCK.

MAGNETOMETER.

IN laboratory determinations of the intensity of the Earth's magnetic field it is often desirable to be able to obtain the deflection observations with an accuracy greater than is possible with the usual glass pointer over a 15 or 20 cm. divided circle and yet not incur the expense and elaborateness of the telescope and scale, or the lamp and scale.

The method devised is intermediate in accuracy between the two methods above mentioned and gives the readings in tangents of the angle directly.

A in the accompanying Fig. 1 is the magnetometer with a plain mirror about 2 cm. in diameter with a vertical black line across the center of its face, B & B' are the scales upon which the deflecting magnet M is placed, S is a scale, a common meter stick will do, mounted perpendicular to B at a distance of one meter from the magnetometer needle at A. Upon the scale slides the sight, P, shown $\frac{1}{2}$ natural size in Fig. 3. It consist of a piece of sheet brass about 0.5 mm. thick, slit and bent so that two side strips, n n, slide upon one side of the scale and the middle one, o, upon the other side, toward the magnetometer; h is a hole about 1 mm. diameter, and the side toward the mirror is covered with white paper upon which is a cross X. By a series of simple sightings the magnetometer A is oriented in line with the scales B and B', and upon their common zero. Placing the sight upon the point of the scale S directly over the axial line of B, A and B', the whole apparatus is to be so oriented



that on looking through the hole *h*, the cross *X* is seen reflected in the mirror of *A* with its intersection upon the vertical line. The magnets are upon the back of the mirror shown $\frac{1}{2}$ natural size at Fig. 2. *D* is a wing dipping into an oil cup and acting as a damper. Of course, this method of sighting brings the hole *h* and cross *X* into the plane normal to the mirror. The magnet *M* being placed in position, the mirror is deflected and the sight *P* is slid along the scale *S* until the cross is again seen coincident with the line upon the mirror. The difference between this and the previous setting of the slide expressed as a decimal of a meter will be the natural tangent of the angle of deflection, and is easily correct to the third, with a fair approximation to the fourth place of decimals. *P* being always set on the normal to the mirror and its position measured upon the tangent to a circle whose radius is one, the reading is always the natural tangent of the angle. This method of reading angles will be found convenient in many other cases.

VARIOMETER.

The method of reading angles above described has been applied to an apparatus for measuring the local variations in the horizontal component of the Earth's magnetism with an error somewhat less than 1%.

Fig. 4 shows the apparatus about one-third natural size. It consists of a magnetometer *M*, similar to that shown in Fig. 1, so mounted as to be movable on a slide *A*. *B* is a coil of copper wire of about 5 ohms resistance whose support is also movable upon a scale parallel to *A*, so that *M* is upon the axis of *B*. Two Daniel cells at *C* and *C'* (*C'* is removed in the cut) send a constant current through the commutator *D* and the coil *B*. The sight *P* is similar to that shown in Fig. 3. The scale *S* is divided to read horizontal intensity directly. That is with zero at the center, distances *d* either way upon the scale are computed according to the formula, $d = \frac{KC}{H}$. *H* is the horizontal component of the earth's magnetism, *C* the cur-

rent in the coil and K its factor. KC can be found empirically by assuming values for d and H , which will be convenient and leave the magnetometer at a suitable distance from the scale S . Of course if it is preferred one can use a millimeter scale and read the tangents and reduce each time. The operation with the apparatus is as follows:

the horizontal intensity found for the fiducial locality. The coil B is then slid backward or forward until the mirror normal falls upon the cross of the sight. Everything is then left in position and the variometer taken to the second station; the sight being adjusted normal to the new deflection of the mirror, the reading will be the intensity at that place. Thus the in-

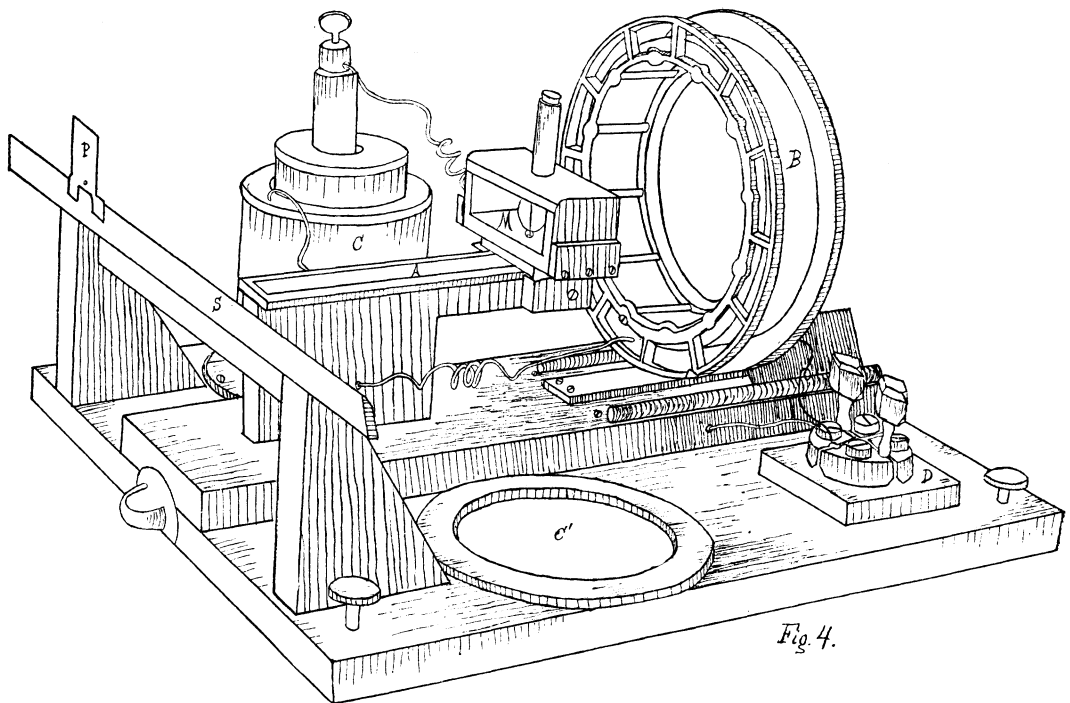


Fig. 4.

Before the current in B is started, the sight is put at zero and the instrument oriented at the standard locality as described for Fig. 1. This oriented position should be so marked that the variometer can be easily and quickly returned to it. Similarly the oriented positions at the various stations should be established before commencing the observations.

The current is started and allowed to flow till fairly constant. When observations are to be made, the sight is placed at the point upon the scale reading the same as

the instrument gives the horizontal component directly. Naturally one must always take the precaution to commutate the current, and take frequent check readings at the fiducial location.

In this way observations about a room or building can be conveniently made and results obtained whose errors are certainly not greater than the daily and other fluctuations of intensity. Naturally by increasing the distance from the mirror to the scale and the precautions for constancy of current, one can obtain more accurate re-

sults, but would correspondingly lose in compactness and portability. The apparatus as illustrated has been used in the physical laboratory at Columbia and has proved itself very simple and useful.*

COLUMBIA COLLEGE, November 18, 1895.

MEASUREMENTS OF THE ACCURACY OF RECOLLECTION.

WE know that ordinary observation and recollection are not altogether reliable. We do not credit all the stories that we hear, even though we may not doubt the good faith of the narrators; we see that conflicting evidence is offered in courts of justice when no perjury is intended; we regard as partly mythical records supposed for many centuries to describe historical events. But we do not know how likely it is that a piece of testimony is true, nor how the degree of probability varies under different conditions. If we could learn this by experiment the result would be a contribution to psychology, and would at the same time have certain important practical applications.

*The above drawing of the local variometer was made by a method which may prove useful to others, and which, so far as I know, is new. It is often desirable to get a perspective line drawing of a rather complicated piece of apparatus without employing a skilled artist, or consuming too much time. To produce the above cut a small photographic negative of the variometer was taken, from which a contact positive was made. The positive was placed in a projection lantern and thrown upon a screen consisting of a piece of drawing paper upon a board, the size of the image being two or three times as large as the cut. The outlines were then traced in with pencil, and one can also shade directly where desired. This sketch was drawn over with india ink and made ready for the photolithographer. The advantage of this method over drawing upon a silver print, which is afterward 'dismissed' is that the drawing and tracing is done upon a larger picture than the final cut, and hence a coarser style may be employed and yet the desired fineness attained in the final reduced cut. Of course a projection lantern of some sort is desirable, but a very simple one will do. The conventional shading in the variometer was put in after the tracing was finished.

W. HALLOCK.

I have tried in various ways to secure a quantitative determination of the reliability of recollection and evidence, and will here report on the answers to some questions asked the junior class in psychology in Columbia College in March, 1893. The questions were answered in all or in part by the fifty-six students present.

Several simple questions were first asked and the students allowed in each case one-half minute to consider and write the answer. They were also requested to assign the confidence which they felt in the correctness of their answer—*a* if quite certain, *b* if tolerably certain, *c* if doubtful, *d* if the answer were a guess.

The first question was 'what was the weather a week ago to-day?' The answers were pretty equally distributed over all kinds of weather which are possible at the beginning of March. Of the 56 answers, 16 may be classed as 'clear,' 12 'rain,' 7 'snow,' 9 'stormy,' 6 cloudy and 6 partly stormy and partly clear.* It seems that an average man with a moderate time for reflection cannot state much better what the weather was a week ago than what it will be a week hence. Yet this is a question that might naturally be asked in a court of justice. An unscrupulous attorney can discredit the statements of a truthful witness by cunningly selected questions. The jury, or at least the judge, should know how far errors in recollection are normal and how they vary under different conditions.

When asked 'what was the weather two weeks ago?' 20 students answered 'clear,' and 18 'stormy.' The confidence in this case was slight, only two being sure that their answers were correct and 8 having some confidence, while the others were doubtful or did not answer at all.

We ought not, indeed, to conclude from these conflicting answers that no inference as

*On the day in question it snowed in the morning and cleared in the late afternoon.

to the weather on those days can be drawn. Almost nothing could be inferred from any single answer, but the answers taken together give information of a degree of exactness which may be defined. We can, however, better consider this matter in connection with questions requiring a quantitative answer.

Three questions were asked with a view to learning the ordinary accuracy of observation: "Do chestnut trees or oak trees lose their leaves the earlier in the Autumn?" "Do horses in the field stand with head or tail to the wind?" "In what direction do the seeds of an apple point?" The questions were all answered correctly more often than incorrectly, but only by a moderate majority. Thus 30 students thought that chestnut trees lose their leaves the earlier in the Autumn, and 21 were of the opposite opinion; 34 students thought that horses in the field stand with tails to the wind, and 19 thought they stand facing it. Thus in only about three cases out of five will a college student answer such a question correctly.

Each class of persons would of course have a different index of precision. In the present cases country boys would probably do better, whereas in other directions, as in judging of character, they might not do so well. This opens up an interesting direction for research. Is the ordinary observation of men or women better? of students in classical or scientific courses? etc.

The degree of confidence may be noticed. The students were sure their answers were correct in all 34 times, and in these cases they were in fact correct 27 times. They were somewhat or quite doubtful in all 70 times, and in these cases were correct 37 times, scarcely more than a majority. Their judgment of their own accuracy was therefore of some value, and the degree of confidence can with advantage be taken in

ordinary testimony. But there is great individual difference in this respect. Some observers are nearly always sure that they are right, whereas others whose decision is equally or more likely to be correct are much less confident. In other and more elaborate experiments I have found that when an observer is entirely doubtful, for example as to which of two weights is the heavier, and makes a guess, his guess is more likely to be right than wrong. This opens an opportunity for determining the part played by subconscious inference in the decisions of daily life, as in judging the the character from the face.

As regards the direction in which the seeds in an apple point, 24 answers were 'upward,' or 'toward stem;' 18 'toward center;' 13 'downward,' and 3 'outward.' The reader may be left to decide whether or not he knows in what direction the seeds in fact point, and what information he can obtain from these answers.

Two questions were asked, the answers to which measure the ordinary accuracy of information: "Was Luther or Michel Angelo born the earlier and by how many years?" "In what year did Victor Hugo die?" Michel Angelo was assigned the earlier year in 29 of the 45 answers. The average of the answers placed his birth 12 years before that of Luther, which is nearly the correct value (8 years). The average departure from the correct value was 54 years, which measures a considerable degree of ignorance.

The average assigned the death of Victor Hugo 12 years too early, with an average departure from the true date of 13 years. The median would here give a more correct date, as the average is unduly influenced by a few who assigned a very early date. The extreme values, indeed, betray great ignorance. One student thought Hugo died in 1790, another that he is still alive. One student thought that

Michel Angelo was born 300 years earlier than Luther.

Three questions were asked intended to determine the average accuracy in estimating weight, distance and time. These were the weight of the text-book (James' *Briefer Course in Psychology*) used by the class, the distance between two buildings on the college grounds and the time usually taken by students to walk from the entrance door of the building to the door of the lecture room. The results are shown in the accompanying table, there being given the approximate actual magnitude, the average estimate with the constant error, the average departure of the estimates from the average estimate and from the actual magnitude and the median.

Estimation of	Actual Magnitude.	Average Estimate.	Constant Error.	Average Residual.	Average Error.	Median Estimate.
Ounces,	24	17	- 7	5	8	16
Feet,	310	356	+46	179	162	250
Seconds,	35	66	+31	36	40	60

It thus appears that in these cases there was a marked tendency to under-estimate weight and to over-estimate time. Length was over-estimated, but to a less degree. For the magnitudes used the average vari-

ation was about one-third of the weight and one-half of the distance or time. The actual errors were larger in the case of weight and time, but not in the case of distance. The middle estimate or median value is in all cases smaller than the average. The degree of confidence of the observer does not in these cases seem to measure objective accuracy.

Curves are subjoined showing the distribution of the estimates. The residuals are divided into classes of the size of one-half the theoretical probable errors, and the ordinates represent the percentages of the whole number of observations falling within each class.

The curves approach the bell-shape required by the theory of probabilities, but not very closely. The departures are partly due to the limited number of observations (56 in each case), and the tendency to estimate in round numbers; in estimating time $\frac{2}{3}$ of the estimates were $\frac{1}{2}$, 1 or 2 minutes. But there is a large constant error, and in addition there is an excess of large positive errors which makes the average in all cases larger than the median. This tendency obtains in nearly all variations and measurements and has not received the attention it deserves. The aver-

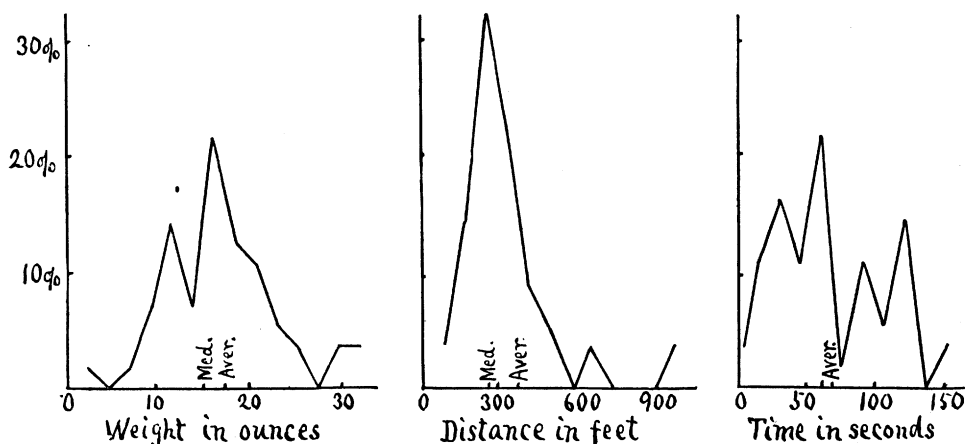


Fig 1. The distribution of errors in estimating weight, distance and time.

age weight of men may be 150 pounds, and there are men weighing 300 pounds, but none weighing 0. In actual measurements it is probable that large positive errors occur more frequently than negative errors of the same size.

When students were asked what was said during the first two minutes of the lecture in the same course given one week before, the accounts were such that the lecturer might prefer not to have them recorded. From the testimony of the students it would appear that two minutes sufficed to cover a large range of psychological

times, but the average estimate of 4,022 had an average variation of 2,669 times. It might be supposed that the number of times was in any case sufficient to impress a tolerably exact recollection of the hall, but the drawings vary to such an extent that any one taken at random would be likely to give an entirely false impression. An examination of the many drawings, however, leaves on the mind a fairly exact idea of the hall, and it would be possible to make a composite drawing which would be found to approach a correct ground plan. Three of the ground plans (supposed to be

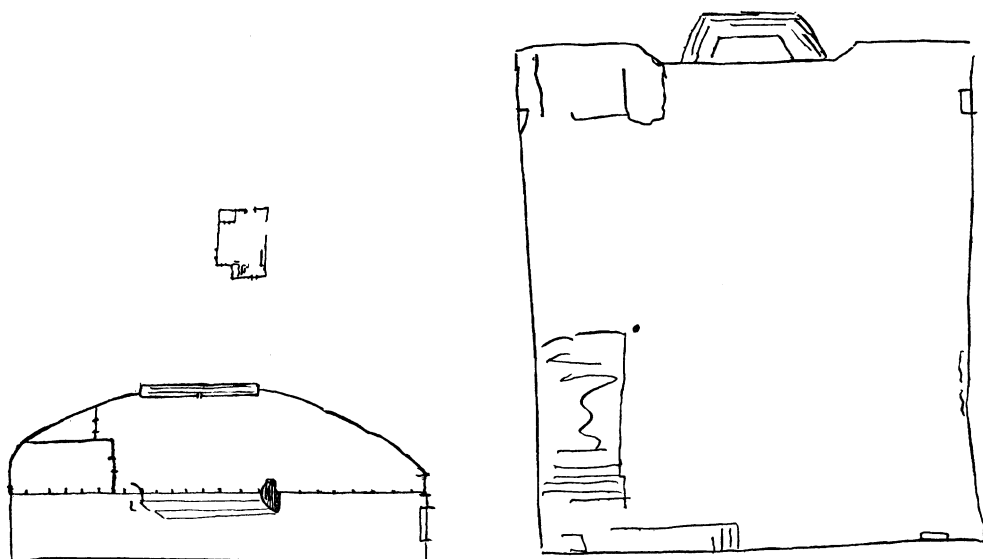


Fig. 2. Ground-plans of a hall drawn from memory (scale 1:96).

and other subjects, and to make many statements of an extraordinary character.

The last task set was to draw in a scale of about $\frac{1}{4}$ inch to the foot a ground plan of the entrance hall of the building in which the class met, ten minutes being allowed. The students were also asked to state about how many times they had passed through the hall. All the students (with some possible exceptions) had passed through the hall about an equal number of

drawn on the same scale and here reduced about one-half) are subjoined. This is worth the while if only to emphasize the worthlessness of many hundred casual observations as compared with one measurement.

Psychology is continually gaining ground as a natural and even as an exact science, and some progress is made when in any direction the surmise of daily life is superseded by systematized facts and measurements.

It is sometimes said that the useful applications of the material sciences have no parallel in the case of the mental sciences, but I venture to maintain that psychological experiments may have a high degree of practical value. Thus, determinations such as those here described are useful in various ways.

It would be of value to an individual and to those having dealings with him if he could be assigned a definite index of precision. This could be determined early in life, and the effects of environment and methods of education could be determined. It is generally acknowledged that children should be treated as individuals and not as bits of stone to be shaken together until they became marbles, equally round. We consequently need to study methods which will discover individual differences early in the life of the child. Education may properly be devoted to overcoming defects which would interfere with usefulness, but perhaps its more important function is to strengthen qualities which the individual possesses and which may be developed so as to serve his welfare and that of society. From the point of view of science, private benevolence and State aid should be directed less to supplying the cripples with crutches than to supplying the agile with ladders. For this purpose it is evidently important to devise tests which will demonstrate natural aptitudes while the child is very young.

It is especially desirable to devise some objective method to test the fitness of candidates for the civil service. Examinations are of great importance in merely securing some method of appointment other than reward for personal or political services rendered. But the form of examination has often only an artificial connection with the duties of the official. The story is told that in answer to the question "what is the distance of the moon from the earth?"

the candidate replied that he did not know, but that it was not so near that it would interfere with his work in the post office. It is, indeed, a fact that the man who had independently observed (contrary to the testimony of novelists) that the crescent moon does not rise in the evening, or (contrary to the testimony of poets) that a baby does not reach for the moon, would discover mental qualities of greater importance for most work than the man who remembered the number of miles from the earth to the moon. Of course the accuracy of observation would only be one of a number of tests which could be applied. The candidate for post office clerk whose eyesight is good; who can accurately judge of the weight of a letter; who can make many similar movements in succession without becoming fatigued; whose range of perception is large so that he can perceive at a glance the address on an envelope; whose reaction-time is short, so that he can quickly distribute the letters, etc., would probably be a more efficient public servant than one who passed a slightly better examination in grammar and arithmetic. Stress should be laid on the advantages of obtaining quantitative results. In this case the candidates can be arranged in order without any chance of prejudice or mistake on the part of the examiner. The report would show that A has passed a better examination than B, and that the chances are (say) nine to one that this result is correct.

As a last example of the usefulness of measurements of the accuracy of observation and memory I may refer to its application in courts of justice. The probable accuracy of a witness could be measured and his testimony weighted accordingly. A numerical correction could be introduced for lapse of time, average lack of truthfulness, average effect of personal interest, etc. The testimony could be collected in-

dependently,* and given to experts who could affirm for example that the chances are 19 to 1 that the homicide was committed by the defendant, and 4 to 1 that it was premeditated.

A proper application of measurement and the theory of probabilities to the affairs of daily life would add greatly to intellectual detachment and clearness of view. It would be salutary to have in mind the probable error of the newspaper one is reading. The historian could assign the probable accuracy of each event which he narrates, in the same manner as the physicist assigns a probable error to his measurements. We should know what reliance we can place on the stories we hear, and on our own memory of past events. When the relative probabilities of the various conflicting claims of business, politics and religion are expressed in simple numerical formulas, a great part of the wasted energy of life may be directed to useful ends. It is a long way to travel, but we should advance when and how we can.

J. McKEEN CATTELL.

COLUMBIA COLLEGE.

CURRENT NOTES ON ANTHROPOLOGY (XIV).

LATEST WORDS IN CRANIOLOGY.

IN the 'Monitore Zoologico Italiano,' for May last, Dr. L. Moschen presents an able sketch of the recent conflicts of opinion in craniology, and declares in favor of what he calls 'the natural method.' This is that of Prof. Sergi, already explained in this journal. Moschen shows that the method of Kollmann leads to erroneous results, and that at present no unanimity prevails as to the ethnic significance of skull forms. In this he is unfortunately most correct.

* The independently formed verdict of three jurors, if concordant, would probably have more validity than the unanimous verdict of twelve jurors in consultation. Questions of such great practical importance as this could be definitely settled by the proper psychological experiments.

Prof. Dr. Busch, of Berlin, has a carefully prepared article in the 'Verhandlungen der Deutschen Odontologischen Gesellschaft' (Bd. VII., Heft. 1), on the cranial forms in different races of men. The paper is marked by close observation and sound judgment. His conclusion is that "the cranial differences of races do not lie in particular measures, nor in the relation of the indices, but in the coincidence of certain peculiarities of the head and face which can scarcely be expressed numerically, but can be shown by accurate pictorial presentations of the different aspects of the skull." This is not far from 'the natural method.'

YUCATECAN STUDIES.

THE almost simultaneous appearance of four works, all of exceptional merit, on the archæology of Yucatan cannot fail to excite a wide interest in that country.

First may be named the fifth part of Mr. A. P. Maudslay's contributions to the 'Biologia Centrali-Americana' (London, July, 1895). It is devoted to Chichén Itzá, and contains 24 pages of text and an atlas of 25 plates. The first of these is a very carefully prepared map of Yucatan and Tabasco. Then follow views of the monuments of the site, analyses of the architectural details, and faithful copies of the inscriptions. The singular round tower, called El Caracol, is the subject of especial attention.

Next comes Mr. H. C. Mercer's 'Hill Caves of Yucatan' (Phila., Lippincott & Co.). This gives the results of very painstaking excavations in the caverns of the Sierra de Yucatan. Striking illustrations and an attractive literary style add to the high scientific value of the volume. The author's conclusions may be briefly summed up by the statement that nowhere did he discover traces of an occupation of the soil anterior to the Mayas, or of a civilization

less advanced than that we know they enjoyed at the Conquest.

Briefer is the report of Mr. Theobert Maler of his many years explorations of the ruined cities of the peninsula. It is published, with numerous photographic reproductions, in the *Globus* for October. Some of the ruins he visited have been previously unknown, and present architectural details of a higher order than any yet described.

Finally, though by no means of least importance, is an essay by Prof. W. H. Holmes, of the Columbian Museum, Chicago. It is the result of personal studies of various ruined cities last winter, and I may speak of it from a sight of the proofs. The author portrays with consummate skill the development of Mayan architecture, and solves many problems with reference to it which have hitherto remained obscure.

D. G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

CURRENT NOTES ON PHYSIOGRAPHY (XX).
THE DISTRIBUTION OF PLANTS AND ANIMALS.

THE manner in which the distribution of plants and animals should be treated in the study of physical geography is a vexed question. The preference of the writer would be to leave the actual distribution of species to botany and zoölogy, and to introduce in geographical study only such examples of distribution as shall illuminate the control exercised over plant and animal life by the forms of land and water and by the physical conditions of climate; or such other examples as shall illustrate the interdependence of plants, animals and man, in the savage state of local supply or in the civilized state of extended exchange. Classifications of plants and animals, such as appear in certain text-books on physical geography, are quite out of place; even faunal and flora areas are not, as such, proper geographical subjects, but belong in zoölogy

and botany. In a word, when a plant or animal, or the area of its occurrence, is the object of study, the discipline is biological; when the forms of land or water, or the conditions of climate which control the growth or distribution of a plant or animal is the object of study, the discipline is geographical. The great variety and number of plants and animals encouraged to grow in the luxurious belt of the equatorial rains, or the sparsity of individuals and the specialized forms and colors of plants and animals that struggle to survive in the trade wind deserts, are examples of geographical themes; the particular characteristics of these various plants and animals, and their systematic relationship to the inhabitants of other regions, are examples of biological themes.

PLANTS OF THE ALPINE REGION.

THE peculiar forms assumed by plants of the Alpine region, offering excellent material for truly geographical study as defined in the preceding note, are described entertainingly by G. Bonnier (*Les plantes de la région alpine, et leurs rapports avec le climat. Ann. de géogr., Paris, iv. 1895, 393-413*). The plants are dwarfed, the stalks are low, the leaves are close to the ground in rosettes or tufts, the roots are large in proportion to the stalks and leaves; new individuals are often propagated from runners, so that the ripening of seeds need not be depended on. Growth begins before the snow of winter entirely disappears, and during the short summer advance is made rapidly to maturity; different phases of growth being abbreviated and their succession accelerated. While accounts of these peculiar features are used to intensify the appreciation of the average temperature of the Alpine region, of the long-continued presence of its snow cover and of the brevity of its open summer, they properly belong under geography; but when they are followed

by experiments on plants of the same species grown at high and low levels, and on minute observations of modifications of structure at high levels, the subject assumes a decidedly botanical flavor. Botanists as well as geographers will therefore find interesting matter in Bonnier's account of his gardens in the Alps and the Pyrenees, where for some years past he has cultivated plants taken from lower lands. The figures illustrating the difference between plants grown from two parts of a single rootstock, one in the Alps, the other in the lowlands, are particularly instructive from the remarkable modifications of the normal form produced by the Alpine habitat.

W. M. DAVIS.

HARVARD UNIVERSITY.

SCIENTIFIC NOTES AND NEWS.

WE are extremely glad to state that the report of the death of Dr. George M. Dawson, quoted in the last issue of this journal from the *London Standard*, was false. It was due to confusing the cable dispatch announcing the death of Dr. George Lawson. *Nature* states, in its issue of November 21st, "after a part of last week's issue of *Nature* had been printed off, containing a note announcing the death of Dr. George Dawson, we were rejoiced to be able to stop the press and cancel it, as a cablegram contradicted the rumor." We also should have been able to contradict the accounts contained in the English papers, had we not been compelled to go to press one day earlier than usual owing to the Thanksgiving holiday.

THE administrative council of the Pasteur Institute, at a recent meeting, presided over by M. Bertrand, permanent secretary of the Académie des Sciences, decided to appoint a subscription committee, with a view to the erection of an international monument to perpetuate the memory of Louis Pasteur.

THE first meeting of the General Committee of the Huxley Memorial was called for Wednesday, November 27th, in the Museum of Practical Geology, Jermyn Street, his Grace the Duke of Devonshire, Lord President of the

Council, in the chair. Resolutions with respect to the form of the memorial were to be submitted to the meeting.

A MEETING of the Council of the Royal Society on December 12th will be devoted to the discussion of the question of Antarctic research. The discussion will be opened by Dr. John Murray, who will be followed by other specialists, each dealing with his own particular branch of science. It is expected that the Council will endorse the report of the Society's Antarctic Committee, urging the necessity for the resumption of Antarctic exploration by means of an adequately equipped Government expedition. It is stated that a well equipped German expedition to the Antarctic continent is now being prepared.

SIR JOSEPH LISTER has been nominated by the retiring president and council for election as president of the Royal Society. The election will take place at the anniversary meeting on November 30th. Prof. Michael Foster has been nominated for reelection as one of the secretaries.

CALVERT VAUX, the landscape architect, was drowned on November 20th. He was born in London about 71 years ago and came to America at the age of twenty-four to become the partner of A. J. Downing. He planned many of the most important parks in America, and New York City is especially indebted to him for the design of Central Park and for his long and able service in the Department of Parks.

THE health committee of the Glasgow Town Council has decided to establish and equip a complete bacteriological department in the sanitary buildings now in course of erection. The laboratory is to be in charge of an expert in bacteriology.

A. M. VILLON died on November 4th, of typhoid fever, at the age of twenty-eight. He was the author of 'Dictionnaire de chimie industrielle' (in course of publication at the time of his death) and other works and editor of 'La revue de chimie industrielle.'

M. DE BERNADIÈRES reported to the Paris Academy of Sciences on November 11th that with the coöperation of the ministers of the marine seven expeditions had been sent out with a view

to the preparation of a magnetic map of the earth. The expedition to Iceland has already accomplished its task in a satisfactory manner, and it is hoped that a map superior to any similar publication may be issued before 1900.

THE next International Medical Congress has been postponed for one year and will be held in Moscow in 1897.

THE paper by Prof. George M. Comstock on 'A Course in Astronomy for Engineering Students,' published recently in this journal (Vol. II. p.502), was read before the Springfield meeting of the Society for the Promotion of Engineering Education.

AMONG the papers announced to be read at an extra meeting of the Royal Society on November 28th were 'Mathematical contributions to the theory of evolution; III. Regression, heredity and panmixia,' by Prof. Carl Pearson, and 'Examination of gases from certain mineral waters,' by A. Kellas and Prof. Ramsay.

AN editorial article in the *Lancet* for November 23rd calls attention to the desirability of testing the hearing as well as the eyesight of school children. Weil found 35 per cent. of the pupils in the schools in Stuttgart, and Moure 17 per cent. of those at Bordeaux, more or less deaf in one or both ears. The degree of deafness is very easily determined by requiring the child to repeat words uttered at a measured distance in a quiet room, and unilateral deafness by closing one or other ear with the finger. Words spoken in a conversational tone should be recognized by those whose hearing is normal at a distance of 15 to 20 meters. In many cases deafness and related disorders may be cured by medical or surgical treatment, and in any case it is important that the deafness of a child should not be mistaken for stupidity.

DR. THOMAS DWIGHT's recent notes on the Dissection and Brain of the Chimpanzee 'Gumbo' in the *Memoirs of the Boston Soc. Nat. Hist.* contains numerous references to other papers showing how large is the amount of individual variation in this species. Although several species of chimpanzee and gorilla have been described it will be interesting to see how they will stand the test of time and more material. Unfortunately specimens of the large an-

thropoids are seldom accompanied by full and sufficient data and not improbably most, if not all, of the species will prove to be subspecies. The large apes seem subject to a large amount of variation. Not only does the orang of Sumatra differ from that of Borneo, though not specifically, but the Bornean oranges differ among themselves in size and color so that they have been divided into three species, mainly on points due to age or sex. Evidently there is much work to be done before the exact status of the large anthropoids can be considered as definitely settled.

AT a meeting of the Engineering Association of the South in Nashville, Tenn., November 13, the retiring president, Prof. Wm. L. Dudley, of Vanderbilt University, delivered an address on 'The Development of Technical Education in the United States.' The following are the officers for the year 1895-96:

Hunter McDonald, President.

W. G. Kirkpatrick, First Vice-President.

J. J. Ormsbee, Second Vice-President.

Lucius P. Brown, Secretary.

W. M. Leftwich, Treasurer.

Wm. L. Dudley, E. C. Lewis, H. D. Ruhm, Jno.

B. Atkinson, Directors.

IN the November number of *The Nineteenth Century* Mr. Herbert Spencer again criticises Lord Salisbury's president's address before the British Association in 1894. Lord Salisbury's address has perhaps received more attention than its scientific importance warrants, but Great Britain is fortunate in having a Premier who is competent to preside over its Association for the Advancement of Science and whose address deserves scientific criticism.

LEOPOLD VOSS has issued a new edition of Kroll's *Stereoskopische Bilder*, to which new pictures have been added by Dr. R. Perlia. The series consists of twenty-six pairs of colored pictures which may be united by the stereoscope. In some of the slides the principal figure is the same for both eyes while the details are different, and in others two different pictures are to be united, as for example a bird and a cage. The pictures are recommended as useful in exercising the muscles of the eyes of children suffering from strabismus, and in any case make a

useful scientific toy. They are sold at the moderate price of seventy-five cents.

Nature states that an International Marine and Fisheries Exhibit will be held at Kiel next year, in connection with a provincial exhibition in Schleswig-Holstein, and will be opened from May 13th to the end of September.

JOHANNES ADOLF OVERBECK, for forty-two years professor of archaeology at the University of Leipzig, died recently, aged sixty-nine years.

M. POINCARÉ reported to the Paris Academy on November 11th that he had found that the moon influences the production and direction of cyclones.

MR. W. R. BROOKS, director of Smith Observatory, Geneva, N. Y., discovered on the morning of November 21st a comet in the southeastern sky. The position was right ascension $9^h 51^m 50^s$, and declination S. $17^\circ 40'$. The comet has a northerly motion.

WE have received part I. of Vol. V. of the proceedings of the California Academy of Sciences, issued on November 18th. The proceedings contain 27 papers, extending to 784 pages and including 75 plates. The work of the Academy is of great interest and importance, more especially as most of the papers are concerned with the fauna, flora and physiography of California. Among the papers are a Review of the Herpetology of Lower California, by John van Denburgh; California Water Birds, by Leverett M. Loomis; The Neocene Stratigraphy of the Santa Cruz Mountains of California, by George H. Ashley; The Fishes of Sinaloa, by David Starr Jordan; Contributions to Western Botany, by Marcus E. Jones, and Explorations in the Cape Region of Baja California, by Gustav Eisen.

DR. JULIUS VON SCHRODER, professor of chemistry at the School of Forestry at Tharandt died on October 27th, at the age of 52. The deaths are also announced of Edward Combes, a well-known Australian engineer; of Lieutenant Otto E. Ehler, the German explorer, who was drowned while making his expedition across British New Guinea; of Oscar Borchert, the African traveler, who died of malarial fever at the Bethlehem Institute, near Ludwigslust,

and of George Edward Dobson, a writer on natural history, who died on November 26, at the age of 51.

MR. F. O. T. DELMAR, of Bayswater, who died on October 14th, has left £100,000 to his trustees to form a fund to be called the Delmar Charitable Trust. Nine-tenths of the annual income from this fund is to be divided between selected charitable institutions in London or its neighborhood, 'having regard to the relative importance and magnitude of each institution.' The testator expresses his desire to benefit in particular the establishments for the care and treatment of epileptic and cancerous patients and the Royal Society for the Prevention of Cruelty to Animals.

UNIVERSITY AND EDUCATIONAL NEWS.

THE Medical Department of Vanderbilt University was reorganized last spring. A new faculty was elected and a graded course of three years was adopted. The faculty consists of ten professors and twenty instructors, lecturers and assistants. Dr. Wm. L. Dudley is dean of the faculty and Dr. Richard Douglas secretary. Dr. W. M. L. Coplin, late of Jefferson Medical College, Philadelphia, fills the chair of pathology and bacteriology. The department has removed this session into the Medical College building lately erected and furnished at a cost of \$70,000.

THE Chemical Laboratory of the Rose Polytechnic Institute was burned on the morning of November 9th. The walls of the Laboratory and a part of the floor were saved, but the rest of the building and the entire equipment were destroyed. The loss was about \$7,500, of which \$5,000 was covered by insurance. The chemical lecture room is in another building, and provisions has already been made for students of the chemical course to continue their laboratory work. A new equipment has been ordered and the building will be rebuilt as soon as possible.

THE ninth annual convention of the Association of Colleges and Preparatory Schools of the Middle States and Maryland was held at Lafayette College, Easton, Pa., under the presidency

of Prof. N. M. Butler, of Columbia College, on November 29th and 30th.

THE Brown University Lecture Association has announced the following courses of free public lectures for the coming season: 'The Religions of China,' by Rev. F. Huberty James, formerly of China; 'Lectures on the History of Song,' by Louis C. Elson, of the *Boston Daily Advertiser*; 'Studies in Social Economics,' by Hon. Carrol D. Wright, Esq., of Washington; 'The Divina Commedia, its Predecessors and Successors,' by Prof. Courtney Langdon, of Brown University. Prof. Charles S. Hastings, Ph.D., of Yale University, will give three lectures upon a subject in physical science to be announced later.

THE calender of the Imperial University of Japan for 1894-95 shows that it ranks among the great universities of the world. All the schools are represented; there are laboratories, hospitals and museums, an astronomical observatory, a seismological observatory, botanic gardens, a marine biological station, etc. The number of students is as follows:

University Hall.....	94
College of Law.....	432
College of Medicine.....	175
College of Engineering.....	229
College of Literature.....	179
College of Science.....	98
College of Agriculture.....	261
Total.....	1468

There are fourteen full professors in the college of science, and a majority of those registered in University Hall are engaged in scientific research. A large part of the work accomplished is published in the *Journal of the College of Science*, which maintains a high scientific standard.

DR. STRAHL, of Marburg, has been appointed to the chair of anatomy in the University of Giessen, in succession to Professor Bonnet, and Dr. Charles B. Ball has been appointed regius professor of surgery in the place of the late Sir George Porter in Dublin University.

On November 1st a laboratory for study and research was opened in connection with the school of physical and industrial chemistry at 42

Rue Lhormond, Paris. By paying a fixed sum monthly to the city anyone desiring to work in this laboratory will have all its facilities at his disposal.

CORRESPONDENCE.

TESTIMONY VERSUS EVIDENCE.

"It is, we are told, the special peculiarity of the devil that he was a liar from the beginning. If we set out in life with pretending to know that which we do not know; with professing to accept for proof evidence which we are well aware is inadequate * * * we are assuredly doing our best to deserve the same character."—Huxley. *Essays V.*, 54.

Some weeks ago (*SCIENCE*, Oct. 4, 1895, p. 435) I quoted from recent numbers of the journal extracts to the effect that the phenomena of vitality are not 'explicable' in terms of physical matter and mechanical energy, and that some of them, those of consciousness and volition, are 'agencies' and causes of structure.

Since many thoughtful students believe that the facts warrant nothing more than a humble confession of ignorance of these matters, I called upon the learned bodies which have endorsed the utterances which I quoted to publish the evidence that proves them; and I ventured the prediction that the publication of this evidence would render the said learned bodies memorable for all time.

So far as I am informed this proof has not yet been published; but a number of correspondents have used the pages of *SCIENCE* to discuss my article, which contained the following passage (p. 439): "What can fundamental disagreement among those who speak with authority lead to except disaster? Are we not bound to find first principles which will command the assent of all thinking men?"

Since this correspondence furnishes new evidence of the imperative need for this agreement regarding the foundations of biology I venture to discuss it.

I some time ago (*SCIENCE*, April 5, 1895, p. 384) expressed my conviction that it is better to be called a vitalist or any other hard name by zealous monists than to be convicted of teaching as proven what we know is not proved; and, so far as I am personally concerned, the only answer I care to give these correspondents is that it is better to be called a 'materialist' or a

'dogmatist' by pious vitalists than to pretend to know what we do not know.

One of these correspondents says (Oct. 18th, p. 521-2) that the opinions I had quoted are a 'scaffolding' which the builder will not confound with his more permanent edifice; and, furthermore, that I fail to discriminate between volition and consciousness, and am no psychologist.

As I plead guilty to this latter charge I gladly take this opportunity to ask the 'Psychologist' a few questions, although I fear lest, in my ignorance, I may be like the patient who endows his wise old family doctor with more power than he really possesses.

Will the 'Psychologist' tell me, in the first place, how any one who does not use the words in a Pickwickian sense can affirm that "when the protozoa *seek* oxygen they have to be *aware* that they *need* it, and must have some *knowledge* of the fact when they get it," without believing that the said protozoa are both conscious and endowed with volition?

I am greatly surprised to find in the same communication (p. 522) the statement that "every naturalist knows that consciousness is a property of protoplasm."

If I were to disclaim any knowledge of this sort I should, no doubt, be told I am no naturalist, but I think no one will make this reply to Huxley, who tells us "We may all have our opinions as to whether mental phenomena have a substratum distinct from that which is assumed to underlie material phenomena or not, though if any one thinks he has demonstrative evidence * * all I can say is, his notion of demonstrative evidence differs from mine."

I have myself been somewhat disturbed in mind by the thought that, while we are bound to find just principles which will command the assent of all thinking men, no less than three mutually exclusive opinions on this matter are current among naturalists. Is it possible that the correspondent holds that these three are one; or is the statement that 'every naturalist knows' so and so only a 'scaffolding,' to be torn down when the writer sees fit?

Without dwelling on this point I wish to ask the 'Psychologist' how, if consciousness is a

a 'property,' a 'conscious state' can be an 'agency.' Can the writer mean that it is the 'state' and not the consciousness which is the 'agency,' or how does the 'Psychologist' interpret these hard sayings?

The writer seems to me to be undertaking a difficult feat, which I shall watch with some excitement—the attempt to ride at the same time the most rampant steeds of both materialists and vitalists.

This correspondent attempts to emend my request for evidence that consciousness and volition can cause structure or anything else, by substituting for the words 'anything else' a specific case (p. 522). I therefore ask the 'Psychologist' whether this concrete statement of the problem of volition makes it any easier to solve.

My modest request for evidence that consciousness and volition can cause anything is more roughly handled by another correspondent (P. 554), who attributes to me, in quotation marks, the assertion that 'consciousness and volition cannot cause structure or anything else.'

This correspondent fills two pages of SCIENCE with an accusation of dogmatism, which would be no more than my just due if I had ever made the statement which he so skilfully constructs out of my words.

We are told that it is a maxim for practice in certain circles to ignore all your opponent says, and to answer what he does not say; but this style of reasoning is no ornament to the pages of a scientific journal, least of all one which had already printed and might have verified the statement which is misquoted.

In the article to which these correspondents refer I insisted that the test of truth is evidence and not conceivability; and I illustrated, by the inversion of the retinal image, the fact that evidence may furnish conclusive proof of truths which are inconceivable.

The question whether this illustration is well chosen or ill chosen has, of course, no bearing upon the accuracy of the general statement, and it seems to me that attention has been directed from the main issue by the comments which have been made upon the illustration, al-

though I cannot admit that this was an unhappy selection.

To the correspondent who asks me (p.287) why I cannot conceive that the image, on my retina is upside down, I can give no answer except that I am made so, although I admit that I have no right to speak for others, and that I should not have used the editorial *we* in the statement referred to.

I find many of the truths of science inconceivable, and while my intellect apprehends the logic of the evidence that the sun is more than a million times as big as the earth, I am absolutely unable to conceive this stupendous fact, or to reconcile it with my experience.

It seems to me that my *conceptions* of nature are pretty strictly regulated by my *perceptions*; and, while I have no desire to measure the minds of others by my own limited powers, I must ask the 'Psychologist' whether this correspondent has not failed to discriminate between apprehension of the evidence for a fact, and conception of the fact itself.

While I suppose every one admits that knowledge of the chemistry and physics of the organism is a necessary condition for progress in biology, I hope Professor Gage will improve every fitting occasion to tell the 'mechanical physiologists' that the problems of life are not yet reduced to physics and chemistry, and that consciousness is not yet proved to be 'a property of protoplasm.'

I shall gladly second him to the best of my ability as often as he insists that no progress in our knowledge of vital actions can be hoped for unless the organic machine is studied as a living being; but I must point out the fact that none of the passages he quotes (p. 590) have any bearing whatever on the problem of the origin of vital phenomena except so far as they show that it is as yet unsolved. This is a very different matter from proof that the problem is insoluble; and a schoolboy who believes that what his teacher has not yet explained is 'not explicable' may be making a most grievous blunder.

We are all of us schoolboys in knowledge of nature, and our admission of ignorance is not dogmatism but caution. I, for one, do not dare to say any natural event is 'not explicable'

by means of the data of physical science; although I am sure all who have studied with me will confirm my statement that I have neglected no opportunity to insist that we have not yet made the slightest approximation to such an explanation of the phenomena of life.

I am, however, equally confident that I know of no approximation to any other explanation; nor do I believe that any one has any moral right to believe in one unless he is prepared to give evidence for it.

W. K. BROOKS.

BALTIMORE, November 19, 1895.

SCIENTIFIC LITERATURE.

Minerals and How to Study Them. A book for beginners in Mineralogy. By EDWARD S. DANA. 12mo, 380 pp. 319 figures.

This elementary book is especially welcome, as for a long time the need has been felt of such a work, by those who are commencing the study of mineralogy. For a full and proper understanding of the science there is needed a knowledge of chemistry, crystallography and physics, and to present the subject, therefore, so that it can be comprehended by beginners is not an easy matter. The books that have previously been available have either been so elementary that the science was not presented with sufficient clearness, or so technical and diffuse that beginners were almost discouraged in trying to become acquainted with the important facts of the science. One of the chief features of this new book is that the author has constantly kept in mind that the subject is being presented to beginners, the use of technical terms has, therefore, been wisely avoided and the subject-matter throughout the book is *readable*.

The first two short chapters are devoted to definitions and descriptions of the occurrence of minerals, and some hints as to how to study and collect them. The third chapter treats of crystallography and structure. The former is treated in a very elementary manner, the difficult mathematical relations are not gone into at all, and only the chief features and peculiarities of the six systems are given. The subject is illustrated not only by outline figures, such as one ordinarily sees in mineralogies, but also by some very excellent wood cuts illustrating pe-

cularities in the grouping and arrangement of crystals and the structure of minerals. Other physical properties such as cleavage, fracture, hardness, specific gravity, color, luster, etc., are treated briefly in the fourth chapter. In the fifth the chemical characters of minerals are discussed, and in the sixth the use of the blow-pipe and simple means of making chemical tests.

The seventh chapter, taking up about one-half of the volume, is devoted to a description of the mineral species. Of course only the common and important ones are considered, the chief features by means of which each mineral may be recognized being clearly brought out and its crystallization or structure well illustrated. The uses to which the mineral may be put are also given. The classification adopted is not the usual and more scientific chemical one, where the minerals are grouped according to the acid radicals, for example, the *sulphates* as one group, the *carbonates* as another, etc., but the minerals are grouped according to the different metals which they contain. In each case there is first given a brief account of the metal and its uses, followed by a description of the common minerals containing it. The silicates, owing to their complexity and the fact that, with few exceptions, they are not economically useful as ores of the metals, are treated in a group by themselves.

In the last chapter some simple rules for the identification of minerals by means of their physical properties are given.

The book is one which certainly will be found very useful, and a careful study of it in connection with a collection of mineral specimens will form an excellent foundation in the science.

S. L. PENFIELD.

The Elements of Botany. By FRANCIS DARWIN. Cambridge, University Press. 1894. Macmillan & Co., New York. \$1.60. Cambridge Natural Science Manuals.

It is a common habit of teachers and writers of botany to select a typical plant for study, one which shall illustrate within itself all the fundamental structures and life processes of plants. Francis Darwin in the volume before us takes up the problem at the other end: that is, he selects typical structures and phenomena and

studies each in some common plant which seems to show a given feature in its most undisguised state or condition. This is evidently the most natural method for the beginner, for it selects those emphatic types of plants which yield the fundamental lessons with the least desultory effort on the part of the student. There is no single plant which illustrates all the phenomena of plant life and structure with equal clearness, and the student who seeks to draw all his typical examples from the one species is likely to obtain only a faint impression of all those processes and anatomies which are more or less obscure in his specimen. But if the student is allowed to range for his material, or rather, if a wide range of material is placed before him, he is impressed rather with general and representative phenomena than with dissection and specialization.

It seems to me, therefore, that the plan of Mr. Darwin's book is excellent. He illustrates the fundamental conceptions of the cell, of reproduction, of nutrition and of fermentation, by the yeast-plant, spirogyra, tradescantia, elodea and elder pith; of reserve materials and germination by the bean and gourd, tubers of potato and artichoke and bulb of tulip; of the phenomena and structures of roots, by broad-bean; stem tissue by sunflower, and the like. The book is a reprint of lecture notes, and this accounts for its brevity and directness of style, and also, no doubt, for some inelegancies of construction. The book is wholly elementary and is divided into fourteen chapters to accommodate 'the work of fourteen mornings,' which comprises the scheme of botanical lectures in the course in elementary biology given at Cambridge, England, to medical students. The book also has an appendix comprising directions for fourteen laboratory exercises to correspond with the class-room instruction. A particularly worthy feature of the book is the steadfastness with which it adheres to the discussion of the particular type in hand, thereby omitting the modifications and exceptions which so often confuse the mind of the beginner.

It seems to be necessary to take issue with Mr. Darwin's interpretation of the morphology of the rosaceous flower. He designates the flower-cup, in which the cherry ovary sits, and

which comprises the greater part of the edible portion of the pome, as the receptacle, whilst Americans have been taught by Gray and others that this cup is a calyx-tube. This flower-cup of the drupaceous roseworts 'is the axis or receptacle of the flower which assumes this remarkable form. The hollowing out of the receptacle brings the points of origin of the calyx, petals and stamens above the ovary.' (P. 170.) The stamens are therefore borne upon the edge of the hollow receptacle rather than upon the throat of the calyx, as we have been taught, and this receptacle is *deciduous* in the drupes! It is generally held that the very proof of being a receptacle is the fact that it persists and bears the ripened fruit. If this cup-ring which falls off the drupe-fruit is really a receptacle, then it is difficult to explain the structure of the rubus flowers upon the same plan, for in them the stamens are clearly borne upon the calyx-rim, and the receptacle persists within the multiple 'fruit.' The only warrant for calling this flower-cup a receptacle is found in the rose-hip; but this organ proves itself a receptacle because it persists and because it bears the fruitlets scattered upon its interior. But the outside covering of the hip is, if analogies with other genera are true, a calyx-tube covering; and in some roses this calyx covering is almost free from the receptacle. It seems to be easy to demonstrate that the flesh outside the carpels or core in the pomes is thickened calyx, and not receptacle; for the carpels all spring directly from the apex of the pedicel (and not from an expanded and cup-like surface, as in the rose-hip), and the sepal tips still persist in the ripened 'fruit.' If the flower-cup in the roseworts is a calyx-tube, then the structure of the flower is fairly uniform in principle throughout the family; but if it is a receptacle in prunus and pyrus, then a different architecture of flower must be assumed for all the rubus-like, fragaria-like and spiraea-like plants.

L. H. BAILEY.

An Introduction to the Study of Seaweeds. By GEORGE MURRAY, F. R. S. E., F. L. S., etc., Keeper of the Department of Botany, British Museum. London and New York, Macmillan & Co. 8vo. Cloth, 271 pp. 8 colored plates and 88 illustrations in the text. \$1.75.

The algæ are least well treated of all the groups of plants in the average text-book, although for purposes of morphological comparison and general phylogenetic consideration they are of the first importance. The author of this most valuable and welcome little book has shown such familiarity with his subject, and such appreciation of the relative importance of detail, that it is much to be regretted that he has confined himself to the marine members and has not treated the group as a whole.

The author has modestly entitled his book, 'An Introduction to the Study of Seaweeds,' but we may venture to predict that it will be used rather as a handbook both by the less advanced and by the more advanced student, combining, as it does, summaries and discussions of the very latest literature and personal researches with such convenience of form and simplicity of style of writing that it is not only valuable to the special student but available also to the general reader.

Mr. Murray, after a general introduction treating of the important topics concerning the seaweeds in general and the division of the group into the four ordinary subgroups fairly well characterized by their color, begins for purposes of convenience with the Olive-green or Brown Seaweeds. Starting with the more complicated forms of these, the rock-weeds and gulf-weeds or Sargassa, he proceeds to the less complicated forms, tracing the simplifications of structure and details of reproduction, step by step down to the lowest forms of the group. It is noticeable, however, that the simplest undoubted member of the group, the *Phæosaccion Collinsii*, described by Farlow from our New England coast, and by Rosenvinge from the Greenland coast, is omitted, whether purposely or not is not evident. It is, however, a form so different in its cylindrical thallus of a single layer of cells, without hairs and without specialized zoösporangia, that a discussion of its relationship with *Punctaria*, for example, would have been of very considerable interest.

The Grass-green Seaweeds follow the Olive-green, and while admirably treated are perhaps less interesting than the latter. It is interesting to note that *Codium* is removed from beside

Bryopsis and *Botrydium*, where it is very commonly placed and put into the heterogeneous assemblage of the Protococcaeæ. We also notice that the animal-like *Ceratium*- and *Noctiluca*-forms find a place near them although of very doubtful affinities.

The Diatoms are placed by themselves as they well deserve to be, and even their superficial resemblance to the Desmids can hardly save them from the suspicion that their affinities are with organisms other than the undoubted seaweeds.

The Red Seaweeds are without question the most difficult and complicated group, not only in vegetative structure, but even more so in the details of the sexual reproduction. Mr. Murray's chapter was evidently written before Wille's paper announcing the discovery of the fusion of the two sexual nuclei had been published.

Schmitz's classification, based upon the variation in the development of the carpospores after the fertilization of the 'carpogonium,' has been followed, and this part will make accessible to the student an excellent account of Schmitz's system in a very convenient form.

The account of the Blue-green Seaweeds occupies the closing chapter of the book, and this is perhaps the least satisfactory part. The very interesting matter of the cell structure is very slightly touched upon, and the relationships between this group and other groups of organisms is barely hinted at. Considering the lack of general information about this group, even the comparative morphology might have received more attention.

It is pleasant to see that the author has not followed, in this book, the terminology of Benet and Murray's *Cryptogamic Botany*, but has used such words as antheridia, carpogonium, sporangium, and the like. The whole make-up of the book is very pleasing, the illustrations in the text are well selected and excellently reproduced, and the colored plates, interesting and valuable to the beginner for whom the book is intended, while lacking absolute accuracy of tint, are perhaps as good as the very low price at which the volume is sold would allow.

W. A. SETCHELL.

UNIVERSITY OF CALIFORNIA.

Korean Games, With Notes on the Corresponding Games of China and Japan. By STEWART CULIN, Director of the Museum of Archaeology, University of Pennsylvania. Philadelphia. 1895. 1 vol. Large 4to. Pp. 177.

This handsome volume is a monograph of rare merit on a branch the importance of which is but imperfectly appreciated even by some of our most advanced ethnologists.

The subject of games, especially the games of children, has been generally regarded as beneath the dignity of real scientific treatment. They have been indulgently regarded as trivial pastimes, or, at best, as amusements only.

A quite different presentment of their significance is advanced in the work before us. The author, drawing most of his information from fresh and unpublished sources, describes ninety-seven games played by the youth of Korea, or by those of older years who retain the love of festal occupations. Some of them sound quite familiar, such as cards, chess, dominoes, dice, backgammon and blind man's buff; others have titles which seem remote from our experience as 'five gateways,' 'clam-shell combat,' 'water kicking' and 'corpse searching!' When, however, we come to examine even these, we recognize in most of them traits of familiar friends.

The methods of playing are explained, the terms employed are given in the Korean and often in the Chinese and Japanese tongues as well, and the position and costumes of the players and their utensils are depicted in twenty-two full-page colored plates by native artists and in 135 text illustrations, many of these also from native sources.

This is the basis of the study, and along with four elaborate indexes, one general and three of names in the languages referred to, make up the bulk of the volume. But the portion which will deservedly attract the thoughtful student beyond this is the Introduction, covering twenty pages, in which the author sets forth with singular lucidity the position which games should hold in ethnologic investigation. This is full of novel and original suggestions, the results not merely of the present monograph, but of years of study of the games of the world.

He claims, and one must concede with the strongest evidence in his support, that games

were originally not festal, but divinatory. Our ordinary checker board represents in its origin the conception of the universe common to nearly all tribes in a primitive condition. The numbers of our cards can be traced back to certain numerical categories and relations which profoundly affected the personal and social life of early tribes and peoples. The diversions of children are survivals of divinatory rites on which depended at one time the actions of mighty states. The magical implement which beyond any other was popular in early divination was the arrow; and the author, in a masterly manner and with rare insight, traces its later development under many transformations down to our cards of the present day. He shows that such evolution was not a transfer from one nation to another, but independent, though closely parallel, in Asia and America; and thus adds one more proof of the universal oneness of human intelligence. This volume will certainly mark an epoch in the proper understanding of what games are in the domain of anthropologic science.

D. G. BRINTON.

SCIENTIFIC JOURNALS.

THE AMERICAN JOURNAL OF SCIENCE,
DECEMBER.

THE number opens with an article by B. O. Peirce and R. W. Willson on the temperature variation of the thermal conductivities of marble and slate. This is an advance publication of the methods and results of an investigation carried on under the auspices of the Rumford Committee of the American Academy of Arts and Sciences. The important result is arrived at that, in the case of the slabs of marble experimented upon, the conductivity remains sensibly constant throughout the whole range of temperature employed, say from about 40° to above 300°. In the case of slate there was found an apparent increase of conductivity of about 30 per cent. between 70° and 300°. E. Cutter describes a practical method of obtaining the keynote of an auditorium. The stratigraphy of the Kansas coal measures is discussed at length by E. Haworth; the article is illustrated by a map of the eastern part of the State and two vertical sections, one a detailed section of the diamond

drill core obtained from the Topeka well, and the other a general section of the coal measures. E. H. Mudge discusses the post-glacial submergence in its relation to central Michigan. W. H. Weed and L. V. Pirsson describe certain igneous rocks of Yogo Peak in the Little Belt Mountains, Montana. They show that Yogo Peak is composed of a core or stock of massive, granular, igneous rock, and that this rock is composed chiefly of augite and orthoclase. The mass shows a progressive differentiation along its east and west axis, with a continual increase in the ferro-magnesian elements over the feldspathic ones. The resultant rock types are classified into three groups: syenite, where feldspar exceeds augite; *yogoite*, where they are practically equal, and *shonkinite*, where the augite dominates, the latter being similar to a rock type previously described.

S. L. Penfield gives directions in regard to the practical use of Retgers liquid to separate minerals of high specific gravity. This liquid consists of a mixture of silver and thallium nitrates fusing at 75° C. and having a specific gravity above 4.5. W. M. Foote gives a preliminary account of a new mineral named *northupite*; this is a chloro-carbonate of sodium and magnesium, and occurs in isometric octahedrons at Borax Lake, California. O. C. Marsh discusses at length the 'Affinities and Classification of the Dinosaurian Reptiles.' This article is accompanied by a large plate giving figures (restorations) of twelve typical dinosaurs, eight American and four foreign species. J. B. Woodworth describes some reptilian foot prints in the sandstone of Avondale, New Jersey. A brief communication by Alexander Agassiz, among the notes and abstracts which close the number, gives some preliminary results of observations of temperature made at great depths in one of the Lake Superior copper mines. The deepest point at which the temperature was taken was 4,580 feet and the temperature was only 79° F. Taking a depth of 105 feet as that unaffected by local temperatures, a column of 4,475 feet of rock is obtained with a difference of temperature of only 20°, or an average increase at the remarkably low rate of 1° F. for 223.7 feet of descent. The usual rate is about 1° F. to fifty feet.

PSYCHE, DECEMBER.

PROF. VERNON KELLOGG discusses the nomenclature of the venation of the wings in insects, with special reference to the veins in Ephemeridæ termed premedia and postmedia by Comstock, which the author does not regard as independent veins; illustrative figures are given. Dr. A. Davidson gives some notes on the nest and parasites of a California bee, *Prosopis vari-frons*, one of the parasites being described as new by Ashmead. By the aid of a new figure, Mr. H. G. Dyar corrects his former account of the arrangement of the hairs in the larva of *Apatelodes torrefacta*, and discusses the number of its stages. Miss C. G. Soule describes the early stages of *Deidamia inscripta*, and Mr. F. H. Sprague records the capture of the large Acridian, *Schistocerca americana*, near Boston, Mass. An account (already published in SCIENCE) is given of the insect collection of the United States National Museum, and the Proceedings of the Cambridge Entomological Club for October are added. In a supplement are illustrated papers from the New Mexico Agricultural Station by Cockerell, Baker and Gillette describing various insects, with some account of their habits.

SOCIETIES AND ACADEMIES.

BIOLOGICAL SOCIETY OF WASHINGTON, 249TH MEETING, SATURDAY, NOVEMBER 16.

PROF. BARTON W. EVERMANN presented a paper on the fishes of the Missouri River Basin.

In its relation to the distribution of its fishes the Missouri Basin may be divided into three parts, viz.: 1. The western or mountainous portion, which is heavily timbered with coniferous forests, which has an abundant rainfall, and whose streams are clear, cold and pure. 2. The middle belt, extending from the forest covered mountains on the west to the western limit of abundant rainfall and deciduous forests on the east, a broad region with limited vegetation and rainfall, large areas of alkali soil which erodes very easily, and whose streams are shallow, shifting and full of alkali and solid matter in suspension. 3. The eastern belt, covered with deciduous trees, possessing abundant moisture, and whose streams are fairly clear and pure, though not cold.

The total number of fishes known to occur in the Missouri Basin is 140 species, representing 24 families and 68 genera.

The principal families represented are the following: Cyprinidæ, 49 species; Percidæ, 20 species; Catostomidæ, 15 species; Centrarchidæ, 12 species; Siluridæ, 10 species.

The great majority of the species are found only in the eastern belt, over 100 of the 140 being found only east of the 102d meridian. Only 11 species are characteristic of the western belt, and only 45 species are known from the Missouri Basin portions of North Dakota, Montana, Wyoming and Colorado.

In the middle belt there are few species and all the fishes there have a more or less bleached appearance, as a result of the peculiar environment of the alkaline water. Perhaps the best example of bleaching is seen in the flat-headed minnow (*Platygobio gracilis*) which, of all fishes, seems best adapted to these conditions.

One of the most interesting results of the field work upon which the paper was based was the definite determination of the westward limit of spiny-rayed fishes. West of the 96th meridian only a dozen species of this large group are known. Three species were found as far west as 98°38', while only a single specimen (*Etheostoma iowæ*) was found as far west as 100°30'.

Dr. Frank Baker spoke of the nomenclature of nerve cells, calling attention to the unsatisfactory character of the terms hitherto proposed for the elementary units of the nervous system. The following were especially mentioned:

Neuron (Waldeyer), has the form of a collective; *neurodendron* (Kölliker), cumbersome and not characteristic of all stages; *neura* (Rauber), has the form of a plural.

The term *neure* seems better and lends itself well to combination. The cells of the nerve roots (*cellules radiculaires*, von Gehuchten), could be called *rhizoneures*, the columnar cells (*cellules des cordons*), *azoneures*; commissural cells (*cellules des voies courtes*) would be *zygoneures*; long-path cells like those of the pyramidal tract (*cellules des voies longues*) would be *macro-dromic neures*, from Gr. μακρος, δρόμος, long course. Rhizoneures could be divided into neures of sensation, *æsthèsioneures* and neures

of action, *myoneures*. The latter term may perhaps be improved. Further subdivisions could readily be made when found necessary.

Prof. Edw. L. Greene read a paper on some fundamentals of nomenclature.

F. A. LUCAS, *Recording Secretary*.

NEW YORK ACADEMY OF SCIENCES, NOVEMBER 18, 1895.

THE Academy met with Vice-President Stevenson in the chair. The Section of Geology and Mineralogy immediately organized.

The first paper was read by Prof. J. J. Stevenson: 'Geological Notes on the Indian Territory.'

During a visit to Indian Territory in 1895 some observations were made which may aid in bringing together the results obtained in Arkansas and Indian Territory by Messrs. Winslow, Hill, Chance and Griswold, and which suggest relationships between the Carboniferous of Arkansas, Indian Territory and Texas.

The grouping of the coal measures presented by Mr. Winslow for Arkansas answers almost equally well for the eastern part of Indian Territory, as appears from Dr. Chance's sections, though some of the sub-divisions are wanting in the Territory and the bottom of the section is not reached, there being, yet lower, a very important limestone in the Choctaw nation. The workable coal beds of the territory are in the lower portion of the section,—the Booneville stage of Arkansas, at least 2,000 ft. lower than the Spadra semi-anthracites. At present they appear to be available only within the Choctaw nation, along the Choctaw and the Missouri, Kansas & Texas railways. The limestone, of undetermined thickness, belongs to the coal measures as is shown by the fossils. An asphaltic limestone occurs near Dougherty in the Chickasaw nation, apparently not far from the same horizon. Its fossils show it to belong to the Bend stage of Texas.

The Ouachita mountain system of Arkansas and eastern Indian Territory appears to be independent of the Tishomingo and Arbuckle mountain system, which is in the Chickasaw nation and apparently older than the other. The structure of the Ouachita system is beautifully simple and thoroughly Appalachian,

while that of the Chickasaw system is exceedingly complex. The curving trend shown by the Ouachita is so characteristic that one may venture to suggest that in Arkansas it may prove continuous with folds extending into Missouri. Its southern continuation appears to be buried under the Cretaceous overlap of Texas, which, as described by Prof. Hill, completely masks the older structure.

The paper will appear in full in the transactions of even date.

The second paper of the evening was read by Prof. J. F. Kemp: 'Zinc and Lead Mines in Southwestern Virginia.'

The paper was based on a visit of the speaker to the mines the past summer. He first showed their geographical distribution and the general geology of the country. By means of lantern views from photographs taken on the spot, the excessive sub-aerial decay of the blende-bearing limestones was made clear, and the occurrence of the zinc in the mineral calamine as crusts upon the undecomposed limestone and beneath the overlying mantle of clay. It was stated that the chemical reactions which had led to the formation of the ore must have taken place at the ordinary temperatures, and must have been produced by common agents, such as carbonated atmospheric waters, sulphuric acid and sulphate of zinc, produced by the decay of the blende, and silicic acid from the silica in the original limestone. The speaker did not attempt to elucidate the matter further, but cited it as an interesting subject for experiment and investigation.

J. F. KEMP,

Recording Secretary.

AMERICAN CHEMICAL SOCIETY, MEETING OF NOVEMBER 8, 1895.

THE regular meeting was held in the hall of the Mott Memorial Library at 64 Madison avenue, Prof. P. T. Austen in the chair.

The minutes of the previous meeting were read and approved.

The Secretary reported that the letter authorized to be prepared in regard to the death of Louis Pasteur had been received from the Committee and duly forwarded to the French Chemical Society.

Prof. W. P. Mason's paper on 'The Chemical'

vs. the Biological Examination of Water' was read by Prof. McMurtrie, in the absence of the author.

In the discussion which followed, the opinion was general that to arrive at a sound conclusion it is necessary to make both examinations, and that as much information as possible should be known of the history of a water.

Prof. McMurtrie stated that in examining a large number of wells in the State of Illinois he found no cases of typhoid fever resulting from the use of well waters in which the nitrites, free and albumenoid ammonia were all low.

These determinations, in conjunction with careful investigation of the history of a water, he found a pretty safe guide to an opinion.

Dr. Horne described an interesting case of large increase of nitrites on mixing three water supplies, the nitrites being low in each of the waters tested separately. Prof. Speyers suggested that the presence of hydrogen sulfid, or other reducing agent in one of the waters, acting on nitrates in the others, might produce this phenomenon.

A paper 'On the Heat of Solution of Certain Carbon Compounds' was read by Prof. C. L. Speyers.

Dr. Austen read a "Note on Runge's 'Bildungstrieb' of Substances," and exhibited a copy of this old and rare work.

Mr. Cutts read a paper, by T. S. Gladding, 'On the Gravimetric Method of Determining Phosphoric Acid by the Phospho-Molybdate Method.'

'Specimens showing the Effects of Gun Cotton Explosions' were exhibited by Mr. W. H. Burleigh.

The meeting was then adjourned to the second Friday in December.

DURAND WOODMAN, *Secretary*.

BOSTON SOCIETY OF NATURAL HISTORY.

THE Society met for the first meeting of the season on November 6th; 116 persons were present.

The presentation of papers by title, and matters of business announced, the Society listened to Prof. George Lincoln Goodale, who spoke on some peculiarities of Australasian vegetation. Limiting his remarks chiefly to Australia, Prof.

Goodale alluded to the natural and political divisions of that vast island-continent and described, with the aid of a series of lantern slides, some of the chief characteristics of its flora, the northeastern shores fringed with mangroves, the distinctness of the desert vegetation, the size and magnificence of the giant Eucalypts, and the interesting features of species of *Acacia* and *Casuarina* and of tree ferns. Attention was called to the vast number of genera and species that constitute the Australian flora, a single lantern slide showing at a moderate estimate more than 150 species; the total number of species found in Australia is estimated at about 10,000. Australian vegetation is supposed to have been derived from some point westward of the continent.

SAMUEL HENSHAW, *Secretary*.

NEW BOOKS.

Electricity and Magnetism. FRANCIS E. NIPHER. St. Louis, Mo. 1895. Pp. xi+426. \$3.25.

The Intellectual Rise of Electricity. PARK BENJAMIN. New York, D. Appleton & Co. 1895. Pp. 611.

Transmissions par câbles Métalliques. H. LÉAUTÉ and A. BÉRARD. Gauthier-Villars et. fils and G. Masson. Pp. 184.

Les Nouvelles Théories Chimiques. A. ÉTARD. Paris, G. Masson and Gauthier-Villars et fils. Pp. 196.

Guide d'océanographie. J. THOULET. G. Masson and Gauthier-Villars et fils. 1895. Pp. 224.

Histoire de la philosophie atomistique. LÉOPOLD MABILLEAU. Paris, Félix Alcan. Pp. 560.

De Saint-Louis a Tripoli par le lac Tchad. P. L. MONTEIL. Paris, Félix Alcan. Pp. 462.

The Story of the Indian. GEORGE BIRD GRINNELL. New York, D. Appleton & Co. 1895. Pp. x+270. \$1.50.

The Story of the Earth. H. G. SEELEY. New York, D. Appleton & Co. Pp. vi+186. 40 cts.

Der Schuss. FREDERICK BRANDEIS. Vienna, Pesth and Leipzig, A. Hartleben. 1895. Pp. 280.

Englishe Chrestomathie. Vienna, Pesth and Leipzig, A. Hartleben. 1895. Pp. 182.